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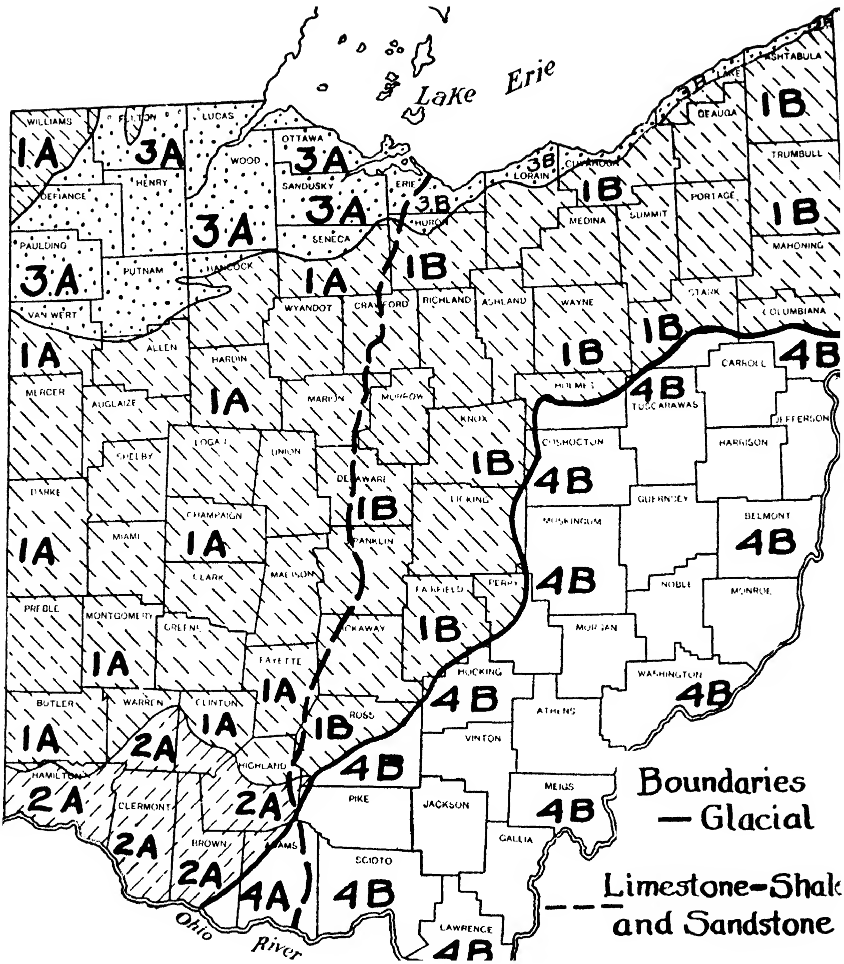
Ohio Agricultural Experiment Station

CONTENTS

OHIO AGRICULTURAL EXPERIMENT STATION

Wooster, Ohio, U. S. A.



Principal Soil Areas of Ohio

Soils: 1A, Glacial limestone; 1B, Glacial sandstone and shale; 2A, Old glacial limestone; 3A, Lacustrine limestone; 3B, Lacustrine sandstone and shale 4A, Residual limestone; 4B, Residual sandstone and shale

BIMONTHLY BULLETIN

OF THE

Ohio Agricultural Experiment Station

VOL. XI, NO. 1 JAN.-FEB., 1926 WHOLE NO. 118

A DAIRY COW, GRACE DAW 2d, AND HER PROGENY

DAIRY DEPARTMENT

In the Bimonthly Bulletin for May-June, 1925 an article entitled "Selecting foundation cows" showed that starting a herd with a few good females is preferable to starting with a larger number of inferior animals, with the hope of breeding up by the use of superior sires. That article recognized the importance of using good sires, and it is not the purpose of this discussion to underestimate the effect of the male side of the pedigree, but merely to review briefly the female offspring of a good cow when mated to sires of equally good breeding.

This cow in eleven consecutive 365-day lactation periods averaged 12,114 pounds milk and 416.9 pounds butterfat. In ten of these periods she received only the ordinary herd care and was milked twice a day.

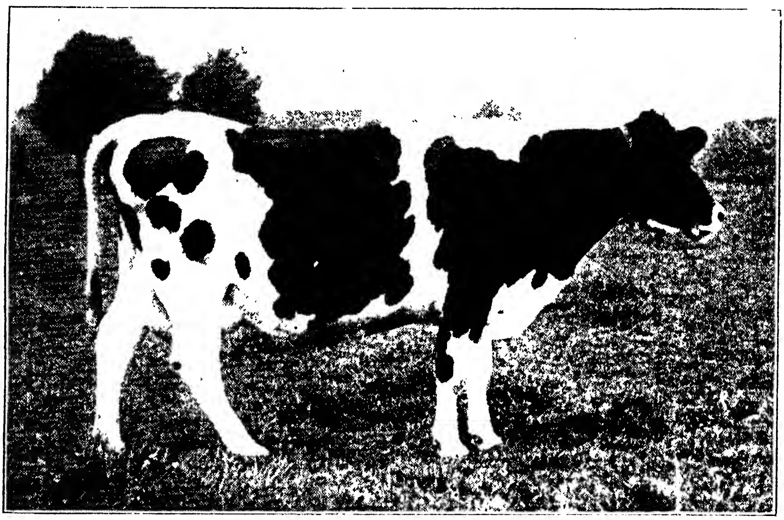
Of the eleven freshenings five resulted in females; five in males; and one in twins, male and female (free martin). Only two of the five daughters have the same sire.

Since Grace Daw 2d dropped her first calf, November 13, 1909, she and her female descendants thru the maternal side have completed 69 lactations. The average of the 58 records of her progeny, 11,767 pounds of milk and 428.9 pounds of butterfat, lacks only 347 pounds of being as high for milk and is 12 pounds higher for butterfat.

In none of the four generations has the production varied greatly from that of the foundation cow. The daughters produced 423 pounds of milk and 6.9 pounds of fat less and the granddaughters 481 pounds of milk less and 23.3 pounds of butterfat more than this cow. The two great granddaughters averaged 99 pounds of milk and 52.1 pounds of butterfat more than their great granddam.

Since the one great-great-granddaughter has only completed three lactations a comparison would not be fair. However, her average of 11,420 pounds of milk and 396.8 pounds of butterfat for these first lactations is very creditable and promising.

That the production of the progeny compared so favorably with that of the parent cow may be attributed in part at least to the sires that were used. To state accurately just how much influence the male side of the pedigree had on maintaining the level of milk production, is, of course, impossible. The story of this foundation cow is presented to show what may follow when sires of good breeding are mated to cows of equally good breeding.



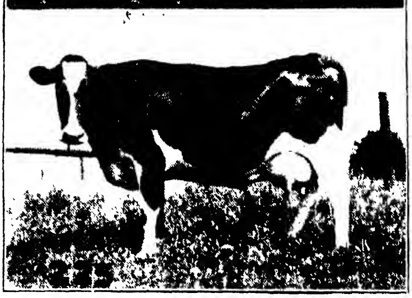
Grace Daw 2d, Cow No. 57, 242,860

In computing the averages for the progeny, all the records for every descendant that has completed one or more lactations have been taken into account. While these figures show that, as a group, the offspring of No. 57 have approximated her average, they fail to bring out the fact that each individual is a profitable producer. True, altho not all of these cows have equalled the production of the original cow, some have exceeded her production and all have been sufficiently good milkers to justify their raising. The record of the progeny of cow 57 illustrates the strong argument in favor of the careful selection of foundation females as well as males: for it is only when both parents are from ancestors which transmit profitable production that the number of unprofitable progeny is reduced to a minimum. **The raising of heifers that later must be discarded because they prove to be poor milk producers is costly.**

Grace Darling of Wooster, 242,861
Daughter of Grace Daw 2d.
Average 7 lactations 10,807 lb. milk, 365.4 lb. butterfat

Grace Darling Hengerveld, 242,862
Granddaughter of Grace Daw 2d.
Average 8 lactations 13,391 lb. milk, 497.9 lb. butterfat

Grace Darling Hengerveld 2d, 254,306
Great-granddaughter Grace Daw 2d.
Average 5 lactations 13,804 lb. milk, 509.9 lb. butterfat



O. A. E. S. Jennie Grace 490,005
Great-great-granddaughter of Grace Daw 2d.
Average first three lactations 11,420 lb. milk, 396.8 lb. butterfat

Developing a profitable herd, even with a good start, is slow work, and merely maintaining a profitable level of production may be attended with difficulties. In the case of the progeny of Grace Daw 2d, the increase in production over the ancestor was very small as shown by the averages. Several better individuals have appeared among the descendants. One of the best cows, a granddaughter, No. 108, made private records in her first two lactations of 506 and 597 pounds of butterfat. This cow died shortly after her 3d calving.

TABLE 1.--ADVANCED REGISTRY RECORDS OF COW NO. 57 (GRACE DAW 2d) AND HER PROGENY

Cow		Age		Milk	Fat
Relationship	*No.*	*Years*	*Months*	*Lb.*	*Lb.*
Dam	57	11	11	21,177.0	711.24
Daughter	70	9	9	17,492.3	592.17
Daughter	107	7	....	22,161.6	753.46
Daughter	121	7	9	15,521.6	558.45
Granddaughter	90	11	10	10,936.4	424.90*
Great-granddaughter	124	6	2	20,377.5	762.97
Great-granddaughter	163	4	11	15,017.8	626.52
Great-great-granddaughter	225	4	2	15,702.0	580.76

*This record was made in 240 days. The best private record for this cow is 17,135 pounds of milk and 642.9 pounds of fat in 365 days.

These records were made on two and three milkings a day and in no case were the cows milked four times a day. The cows were stanchioned the same as the rest of the herd and were never pushed to the limit of their capacity.

While only one example of a foundation cow has been given in this discussion, other like examples showing the wisdom of starting with good cows are by no means uncommon. There are also numerous instances on record where sires have exerted a pronounced influence on the production of their daughters. But it is the careful selection of animals on **both** sides of the pedigree which will give rise to a new generation of uniformly profitable producers.

By "careful selection" is meant the examining of the records in the pedigrees of the parent animals and making observations of the close relatives, when possible, as well as noting the individuality of the animals themselves. A number of good records made by several different animals in the ancestry are more desirable than one or two high records. The productions of the immediate ancestors should be given special emphasis. If the foundation animals have daughters in milk, their records should be given much weight. The old adage, "well begun is half done", applies very nicely in starting or building up a dairy herd.

THE ALL-MASH METHOD OF FEEDING CHICKS AND PULLETS

D. C. KENNARD AND R. M. BETHKE

The need of a simple ration and method for feeding chicks and growing pullets is keenly felt by many poultry raisers. Such a ration should be easily prepared and economical. The more simple the method of feeding, the less skill required. As the skilled feeder is rather exceptional, a method of feeding which involves the least skill is desirable. It is thought that these objects are largely accomplished by the ration and method of feeding here suggested.

An all-mash method of feeding chicks was announced by the Wisconsin Station in 1924. Since 1922 the chicks used in experimental feeding tests at the Ohio Station have received all mash and no scratch grain; and the method was employed for all the chicks and the 1,800 pullets raised by the Station in 1925, with highly satisfactory results. The chicks developed with uniformity, the mortality was low during the brooding period, and the loss of pullets was especially low during the summer range period. When taken from the range in October, they were of good weight, uniformity, and vigor, and yielded a very low percentage of culls.

This method has the advantage of simplifying the whole feeding schedule. The customary procedure of feeding different grain and mash mixtures, each being changed or manipulated at various times according to the age of the chicks, results in much confusion and uncertainty, which may be avoided by the all-mash method of feeding. Suggestions for its application follow:

The mash mixture

Ground yellow corn	70
Winter wheat middlings	20
Meat scraps (50 percent protein)	5
Raw bone meal (chick size)	4
Salt	1

Skimmilk (sweet or sour) or buttermilk is given to drink instead of water during the first 10 or 12 weeks.

Condensed or dried skimmilk or buttermilk may be used instead of the liquid products. Skimmilk and buttermilk are of similar composition. Condensed buttermilk usually contains 28 to 30 percent solids. When fed as a drink, it may be added at the rate of 1 to 2 pounds to each gallon of water. A popular method of feeding this products is to spread the buttermilk paste on the walls of the brooder house or in shallow open troughs, in such amount that the chicks will clean it up in 20 to 30 minutes. Dried buttermilk or skimmilk is fed as a part of the dry mash, the amount ranging from 10 to 20 percent in addition to the above mash containing 5 percent meat scraps.

Oyster shells should be available at all times in separate hoppers or on the ground in the yard. When the chicks are confined indoors much of the time where but a limited amount of direct sunlight is available, it is well to add 3 percent chick-size oyster shells or limestone grit to the mash mixture to insure a surplus of lime to aid in supplementing any deficiency of the anti-rachitic factor. This additional lime is not necessary when chicks receive cod-liver oil or incubator eggs.

A granular mash is preferable to one finely ground. Hence the corn is ground so the largest granules are about the size of pin-head or steel-cut oats. This and chick size raw bone and medium meat scraps give a granular mash, which the chicks seem to prefer to a finely ground mixture. No part of the mash should be so coarse as to permit the chicks to pick it over for certain parts.

SUPPLEMENTS

The foregoing ration is incomplete for chicks confined indoors where direct sunlight and green feed are not available, being deficient in the anti-rachitic factor which prevents leg-weakness. Direct sunlight and green feed, to furnish this factor, are required to make it complete. When it is necessary to keep the chicks indoors much of the time, as often is the case with early chicks or during unfavorable weather of March and April, cod-liver oil or incubator eggs should be added to the ration.

Cod-liver oil is added to the mash at the rate of 1 or 2 percent, the amount depending upon the circumstances or conditions to be corrected. For example, if the chicks are out of doors in direct sunlight occasionally or if considerable direct sunlight enters the brooder house, 1 percent cod-liver oil in the mash may be adequate. It should be remembered that the sunlight which passes thru ordinary window glass is not effective. By direct sunlight, therefore, is meant the sunlight passing thru an open space, not thru glass. The cod-liver oil is first thoroly mixed with a smaller portion of the mash or one of its ingredients, like ground corn or middlings, say 1 pound of the oil to about 5 pounds of the feed, so as to form a crumbly mixture, which is then mixed with the balance of the mash. In this way a good uniform mixture free from lumps is obtained.

Incubator eggs for chicks.—When infertile, dead-germ, and dead-in-shell eggs are available from the incubator, they can be used instead of cod-liver oil as a preventive of leg-weakness, and to induce rapid growth. The eggs are boiled 30 to 45 minutes and then passed thru a sausage mill or food chopper. Either of two

methods of feeding may be employed: (1) The egg material is mixed with an equal weight of the dry mash, to make a moist crumbly mixture, which is fed in open troughs at noon or at 3 or 4 p. m., in such quantity as will be cleaned up in about 20 minutes. Sufficient trough room should be provided so all the chicks can eat at one time. In case of early chicks, the feeding of eggs by either method should be gradually discontinued after the eighth or tenth week, otherwise the pullets may begin to lay too early. Late pullets may be fed the eggs as long as they are available. (2) The chicks may be given the eggs mixed with an equal weight of the mash and fed as in first method, but at a daily rate for each 100 chicks of 3 eggs during the second week (none needed the first week), and one additional egg each week thereafter until the 10th week, when no further increase need be made. In either case the moist egg mash is fed in addition to the dry mash which is kept available all the time.

Range.—A range of bluegrass, clover, or alfalfa is undoubtedly the most valuable supplement to any ration. Direct sunlight and green feed, as afforded by a suitable outdoor range, offer the best insurance for successful growth of chicks and pullets. After the chicks are two or three weeks of age they ought to have the outdoor range when possible.

Green feed.—When chicks are not on a green range, it is necessary, for best results to supply green feed. It should be prepared and fed so the chicks can eat it readily. Green clover, alfalfa, dandelions, and the like, need to be cut in ¼ inch lengths. A small clover cutter is desirable for this purpose.

Clover or alfalfa hay makes a valuable addition to the ration for chicks and may be used to advantage as a supplement, tho not altogether as a substitute, for green feed. If the second or third crop of hay is cut while immature, it will consist largely of leafy material which is comparatively rich in the desired vitamins and minerals, provided it has been carefully cured without getting wet. The leafy material which shatters from clover or alfalfa hay being fed to other stock, if carefully shaken from the hay, may be given the chicks without cutting. When sufficient leaf shatterings are available, they may be used for scratching litter in the brooder house. Fresh material should be added daily if basket feeders are not used.

How to feed clover or alfalfa hay.—The hay should be cut in ¼-or ½-inch lengths by passing thru a clover or silage cutter and fed in 1-inch mesh wire netting baskets. The baskets (Fig. 1) are

cylindrical in shape, about 10 inches in diameter, and 18 to 24 inches high. A receptacle 18 inches in diameter and 3 inches deep, is attached to the bottom of the wire cylinder to catch the shatterings and prevent waste. A cheese box or shallow pan may sometimes be procured for the receptacle, or it may be made of a wooden disc around which is attached a band of sheet iron 4 inches wide. Another wood disc 10 inches in diameter may be nailed in the center of the larger disc to serve as an attachment for the basket. Basket feeders permit the chicks to eat at will. Surprisingly large quantities of the clover or alfalfa will be consumed.

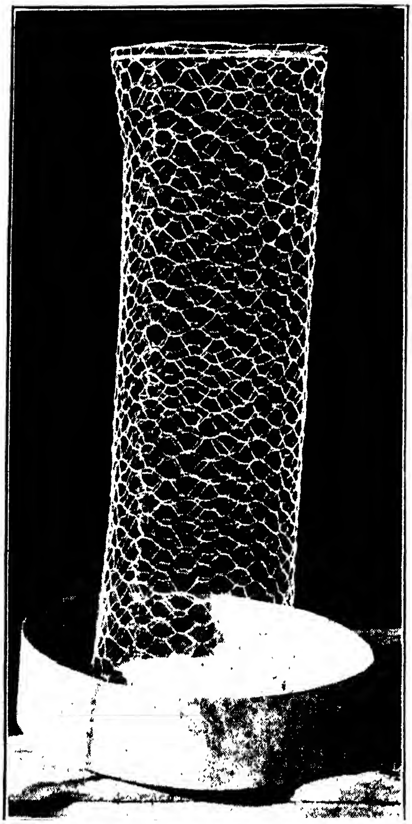


Fig. 1.—Wire netting basket feeder, set on the floor for chicks; later it is suspended by wire from ceiling

METHOD OF FEEDING

Chicks, first ten weeks in brooder.—When the chicks are put in the brooder, they first receive skimmilk or buttermilk to drink and have access to sand on the floor. The dry mash is given as the first feed 48 to 60 hours after completion of the hatch. During the first two or three days, or until the chicks learn to eat, the mash is fed in shallow pans, on egg case flats, newspapers, or thin boards. Later it is fed in troughs (Fig. 2) 8 inches wide, 36 inches long, and 2 inches deep, and kept before the chicks all the time. During the first few weeks, it is well to supply fresh feed three times a day in an amount that will be nearly consumed before the next feeding.

As soon as the chicks begin to scratch mash out of the troughs, 1-inch mesh wire netting grids (Fig. 2) should be placed over the mash. A grid consists of a frame made of number 7 or 9 wire, 1 inch less in width and length than a trough. The netting is then securely attached to the frame. The girds permit the chicks to eat the mash readily, but prevent them from scratching it out. At

first it is well to draw sand or litter in around the troughs so as to make an easy approach to them. Each 400 chicks should have three mash troughs and five drinking fountains.

After four weeks similar troughs 4 inches deep will prove more suitable because of their larger capacity. The deeper troughs should be the same width and length so as to continue using the grids. When the larger troughs are used, no regularity of supplying the mash need be observed except to make sure that ample mash is always available. No change in the ration or method of feeding is made the first 10 or 12 weeks, or during the brooding period. The cockerels, excepting those to be used for future breeders, should be separated from the pullets and kept in separate quarters after six weeks of age until they can be marketed.

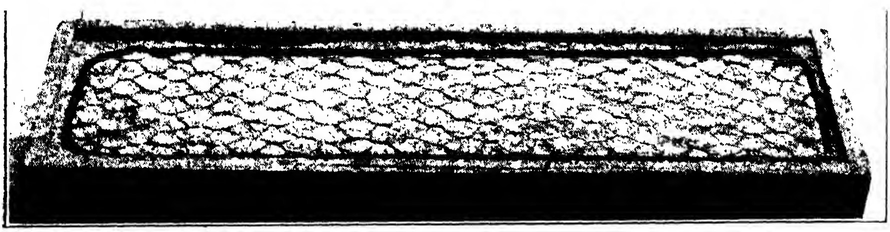


Fig. 2.—Open trough for feeding mash to chicks. The grid, shown above and in place, permits chicks to have easy access to mash but prevents waste from scratching

Pullets on summer range.—The March and April hatched pullets after 10 or 12 weeks, (later hatched pullets after 6 or 8 weeks) no longer require artificial heat and are ready for the summer range. The feeding of milk may now be discontinued, except for late hatches, allowing the pullets to depend upon the dry mash and range, and water to drink. A quantity of oyster shells should be put on the ground in a suitable place where the birds can help themselves at will. In some cases it may be well to supply fine gravel or grit also. The same mash is continued thruout the summer, altho in some instances it may be deemed desirable to reduce or increase the amount of meat scraps to retard or hasten development.

While it is impossible to offer definite suggestions as to the amount of meat scraps required, which will apply to all flocks, generally speaking, 5 percent should give the desired rate of maturity for pullets hatched April 1 to May 20; 2 to 5 percent for March pullets; and 1 to 3 percent for February pullets. This reduction would usually be made during June, or just after the brooder period. Pullets hatched after May 20 will often require 5 to 10 or even 15 percent meat scraps after the brooder period in order to hasten their growth. However, a liberal use of skimmilk or buttermilk offers the most effective means for hastening the development of late hatched pullets. When milk is used, 5 percent meat scraps in the mash is sufficient.

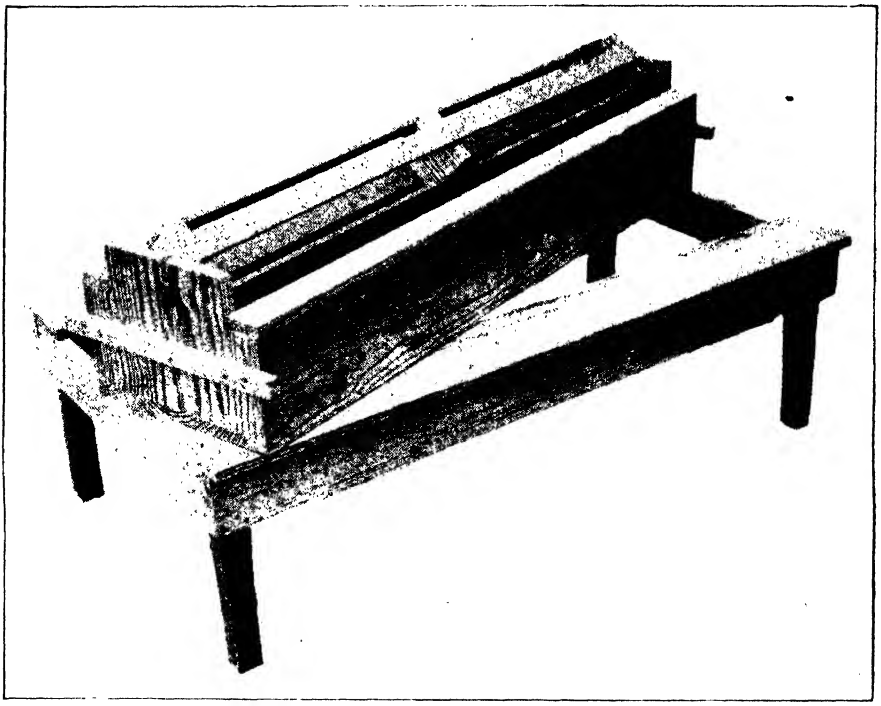


Fig. 3.—The reel mash feeder showing details of construction. The box is easily removed and may be placed on the ground and protected from rain for outdoor feeding

Each flock presents an individual problem as to rate of development, and whether it is hastened or retarded must necessarily depend upon the judgment of the caretaker. These suggestions are only tentative and apply particularly to White Leghorns. Since the heavier breeds usually require a longer period for maturity, the

hatching date, amount of meat scraps, and period of milk feeding, need to be altered accordingly. The rate of maturity is greatly influenced by the strain, the breed, and weather conditions, as well as the ration and condition of the summer range. The exact management of the flock must finally depend upon the caretaker's first-hand experience.

The summer range.—The value of the pullets in October is largely governed by the kind of range they had during the summer months. A special summer range used exclusively for pullets is essential when the number exceeds 100. The ideal range provides ample shade and bluegrass, clover, or alfalfa for forage. If trees, suitable for roosting purposes are near the colony houses, the housing problem is greatly simplified. A 10 by 12 foot colony house will then serve 200 to 300 pullets, provided additional dry mash feeders are located outside the house and protected from rain. Only 200 pullets should be put in such a house at the beginning, but when they start to roosting in the trees, more pullets may be added. If no trees are available for roosting purposes and the pullets are obliged to roost inside, a 10 by 12 foot colony house will not properly accommodate over 100.

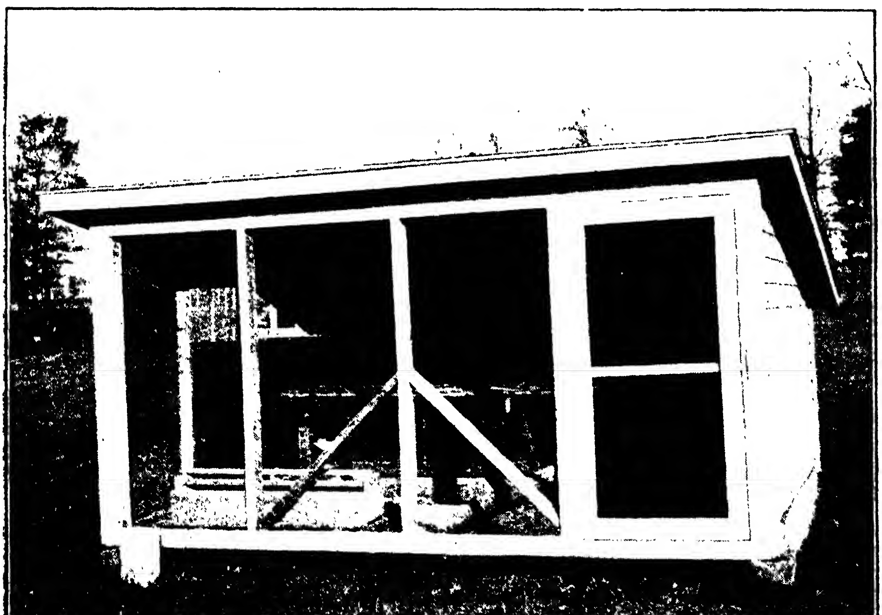


Fig. 4.—Portable colony house for the summer range. This house is 10 by 12 feet; with front entirely open and with neither floor nor windows, its cost is much less than that of a brooder house

The 4-foot reel mash feeders (Fig. 3) are used after the pullets are put on the summer range. One feeder should be provided each 100 pullets. The mash boxes are placed on the ground or floor of the coop with a board 4 inches wide supported 3 inches above the floor on each side for the birds to stand upon.

Portable colony houses (Fig. 4) suitable for the summer range may be built at a much less cost than a brooder house. A portable house for the range needs no floor or windows. A 10 by 12 house with shed roof, 4 feet high in rear and 6 feet in front, with rear and ends made solid, and front, containing entrance door, covered with wire netting, may usually be built for a material cost of about $30. The house is supported 12 inches off the ground. Six or eight roosts can be placed lengthwise 2 feet above lower sills leaving the space in front for the dry mash feeders.

SUMMARY

While the all-mash method of feeding chicks and growing pullets is comparatively new, the development of various phases of its application, and corresponding modifications and improvements may be expected in the near future. However, its merits seem to justify the suggestion that this method of feeding is well adapted for general use by poultry raisers.

Chicks confined indoors away from direct sunlight require cod-liver oil or incubator eggs to promote growth and prevent leg-weakness.

Skimmilk or buttermilk to drink and a green range during the brooding period greatly simplify the problems of feeding and management of growing chicks.

The value of pullets in October is largely determined by the kind of range they had during the summer months.

Bluegrass, clover, or alfalfa for forage and trees for shade and roosting quarters make an ideal combination.

A summer range exclusively for the pullets should be provided when more than 100 are to be accommodated.

GRAIN ALLOWANCE FOR PREGNANT AND NURSING EWES

D. S. BELL*

Farmers who breed their ewes to lamb during the late winter and the early spring are vitally concerned about a ration for these ewes which is both efficient and economical. Any ration which does not meet both of these requirements cannot be considered satisfactory for wintering pregnant and nursing ewes.

Practice has shown that pregnant ewes which go into winter quarters in a good, thrifty, vigorous condition and are fed, after this time, a liberal amount of choice roughages, such as legume hay and corn silage, will require little if any grain until six or seven weeks before lambing. But during the periods of advanced pregnancy, lambing, and nursing, additional demands are made upon the ewe, which must be met. Roughages alone will not furnish sufficient nutrients to satisfy these demands, so concentrates should be included in the ration. Concentrates, however, are usually higher in price than roughages and their use in the ration increases its cost. For profitable sheep production, it is important to know to what extent concentrates should be fed to the ewes from a standpoint of both efficiency and economy.

THE EXPERIMENTS

To collect data to assist in answering this important question, the Department of Animal Industry of the Ohio Agricultural Experiment Station conducted a feeding experiment during three successive winter feeding periods.

The object of the experiments was to observe the effect of feeding various proportions of concentrates to roughages in the winter rations of pregnant and nursing ewes. The duration of the winter feeding in each case was divided into four periods, designated here as the advanced pregnancy period, the lambing period, the first nursing period, and the second nursing period. The distinction made between the first nursing period and the second nursing period is that during the former the young lambs depended solely upon the milk supplied by their dams, whereas, during the latter, the lambs had, in addition to the milk supplied by their dams, access to grain and legume hay offered in troughs and racks placed in lamb creeps.

*The experiments herein reported were planned and Experiment I was conducted by J. W. Hammond, formerly associate in the Department of Animal Husbandry at the Ohio Agricultural Experiment Station.

The table shows the proportions of concentrates to roughages fed to each lot of ewes during the respective periods thruout the winter.

The feeds used in these experiments were shelled corn and cottonseed meal as the concentrates, and legume hay and corn silage as the roughages. The shelled corn and cottonseed meal were fed in the proportion of 5 pounds corn to 1 pound cottonseed meal. The hay and silage were fed in the proportion of 1 pound of the former for each 3 pounds of the latter consumed. Further, 1 pound of cottonseed meal was fed for each 20 pounds of corn silage consumed.

The proportions of concentrates to roughages, shown in the table as 1:1, 1:2, and 1:3, were calculated on a weight basis, using the above named feeds. In these calculations the concentrates included the shelled corn and cottonseed meal plus the corn grain in the silage, which was estimated to be one-eighth of the weight of the silage. Three pounds of corn silage contains approximately the same amount of dry matter as one pound of legume hay, and, therefore, was considered as the roughage equivalent of one pound of legume hay. The ewes were allowed in each case all of the feed they cared to eat but the proportions were kept constant during each of the respective periods as shown in the table.

TABLE SHOWING PROPORTION OF CONCENTRATES TO ROUGHAGES FED DURING EACH PERIOD

Lot	Period and approximate duration*			
	1 Advanced pregnancy 6–7 weeks	2 Lambing 4 weeks	3 First nursing 3–4 weeks	4 Second nursing 4 weeks
	Concentrates: roughage	Concentrates: roughage	Concentrates: roughage	Concentrates: roughage
1	1:1	1:1	1:1	1:1
2	1:2	1:2	1;2	1:2
3	1:2	1:2	1:1	1:1
4	1:3	1:2	1:1	1:1
5	1:2	1:2	1:1	1:2
6	1:3	1:2	1:1	1:2

*Experiments lasted about 18 weeks, starting about the middle of December.

The sheep used were purebred and high-grade Merino ewes of the light B and C types. These ewes varied in age from 2 to 8 years, the same number of each age being placed in each of the six lots. In the first experiment most of the ewes were bred to Southdown rams while the remainder were bred to purebred Merino rams. In the second and third experiments all of the ewes were bred to purebred Merino rams of the B and C types. In the first and third

experiments the ewes were bred to lamb during February and March, in the second experiment they were bred to lamb during March and early April.

The quarters provided for the ewes consisted of a closed shed extending east and west and affording good light and ventilation. Each lot of ewes, 22 in number, was confined to a pen 12 by 19 feet in size including water tub and rack space. In addition to this pen space, each group of ewes had daily access to an outside lot 12 by 36 feet in size, located on the south side of the shed.

TABLE SHOWING PROPORTIONS OF CONCENTRATES TO ROUGHAGES FED AND AVERAGE DAILY FEED CONSUMED, POUNDS

Proportion of concentrates to roughages offered	Amount of feed actually consumed			
	Shelled corn	Cottonseed meal	Alfalfa hay	Corn silage
1:1	1.09	0.37	0.87	2.63
1:2	.44	.28	1.12	3.42
1:3	.12	.22	1.14	3.44

The proportions of concentrates to roughages offered do not coincide exactly with proportions computed from the feed actually consumed. This discrepancy is due to a small amount of this daily refuse, which consisted largely of the coarser stems of the alfalfa plant, some stubble, and, in the silage, part of the stalks and cobs.

RESULTS

The data secured in these tests show conclusively that the feeding of the 1:1 proportion of concentrates to roughages (heavy concentrate allowance) to pregnant and nursing ewes during the entire winter period (Lot 1) is a very uneconomical practice. The daily cost of the ration is high and the efficiency of the ration is likely to be reduced rather than increased by this heavy concentrate feeding.

Where the 1:2 proportion of concentrates to roughages was fed during the entire winter period (Lot 2) the results secured were not altogether satisfactory. Apparently the ewes did not receive sufficient concentrates during the nursing periods to stimulate maximum milk production with the result that the lambs gained slowly and the mortality among the lambs was high.

From the standpoint of both efficiency and economy of the ration, the best results were secured in Lot 4 where the 1:3 proportion (light concentrate allowance) was fed during the period of advanced pregnancy; the 1:2 proportion (medium concentrate allowance) during the lambing period and the 1:1 proportion (heavy concentrate allowance) during the nursing periods.

The data secured from Lots 5 and 6 present some evidence to show that after the lambs have learned to eat grain and hay, the concentrate allowance for the ewes may be reduced. This evidence is slight and since the saving effected was very small, it would seem unwise to draw any definite conclusions until further experiments are conducted.

In the three experiments the average daily cost of feed per ewe in lots 1, 2, 3, 4, 5, and 6 was 3.7, 3.0, 3.3, 3.2, 3.2, and 3.0 cents, respectively.

DUST TREATMENTS FOR THE CONTROL OF OAT SMUT

R. C. THOMAS AND PAUL E. TILFORD

Cause and nature of oat smut.—Two types of smut attack oats in Ohio. They are commonly referred to as the covered smut and the loose smut (fig. page 19). From the economic point of view this distinction does not warrant special concern because both forms are subject to the same means of dispersal and the same control measures.

The smuts are diseases of fungus origin. So far as we know, these fungi are able to attack the oat plant only, and cannot survive for any considerable period as saprophytes upon organic matter in the soil. There has never been any evidence to show that infection may take place thru the agency of air-borne spores after the oat plant appears thru the ground. The time when infection may occur is limited therefore to the short period while the grain is germinating in the soil. The spores carried on the seed begin to grow at that time, and can invade the host only while it is in the early seedling stage. For this reason control measures are arranged to meet this emergency.

Losses due to smut.—Reductions in yield of oats are variable from year to year, yet the losses are of economic importance every season. It is never safe to plant untreated seed from a smutted crop of the previous year. Every diseased plant will bear only a smutted head or panicle. This can result only in a reduction in yield, and a corresponding loss in profit. In addition to this the presence of smut renders the harvesting and threshing operations much more unpleasant.

The estimated loss to the oat crop of Ohio due to smut for the 6-year period of 1918-1923, inclusive, averaged about 4 percent, or over 3,500,000 bushels. The greatest reduction in yield occurred in 1918, involving 7.2 percent of the crop, or 6,145,000 bushels, whereas, in 1922 and 1923 only traces indicating less than ½ percent were found. Since that time the percentage of smut appears to be on the increase. The average for the State in 1924, was 1.5 percent, while for 1925 the estimate was placed at 4 percent.

Smuts of oats: Covered smut left, loose smut right

Unlike the rusts, which are more sporadic, the smuts appear to be periodic in occurrence. Usually a year of heavy infestation has been followed by several seasons with a much lower percentage, until a minimum, varying from ½ to 2 percent was reached. Then, for several successive seasons, there is noted a progressive increase of infection until a maximum, varying usually from 6 to 10 percent

is attained. Natural causes may be in part a contributing factor; but we are more inclined to believe that following years of severe smut infection, more attention is given to seed treatment and to securing smut-free seed. A later relapse in vigilance permits heavy infections which are sure to occur again sooner or later.

First trials with dust.—In 1921 a project was started for the purpose of finding or developing a fungicide which would be available for use in the powder or dust form for the control of smuts of oats. The preliminary trials seemed to indicate that copper carbonate, which was then giving promising results with wheat, could not be depended upon for oats. Consistent results could not be obtained from a series of plots to which the same treatment had been applied. No single compound, involving chiefly the carbonates, sulphates, acetates, and stearates of copper and nickel, seemed to possess adequate fungicidal efficiency for the disinfection of oats.

It was then decided to employ a combination of fungicides for this purpose. Accordingly, the carbonate, sulphate, and acetate of copper were combined with corrosive sublimate, also known as mercuric chloride. One part by weight of each respective copper salt was ground together with two parts of the mercury. These mixtures were used at the rate of three ounces per bushel of grain. Tests were made in one-hundredth acre plots, the grain being drilled as in ordinary farm practice.

The results of these preliminary trials are presented in the table. The formaldehyde methods of treatment afforded virtually perfect control as may well be expected when the treatments are properly made. The combinations of copper and nickel salts with mercuric chloride very clearly gave commercial control and were nearly as smut free as the formaldehyde plots. While in the plots treated with single copper or nickel compounds, the percentage of smut was considerably reduced, the degree of control was not so satisfactory as in the plots where these salts were used in combination with corrosive sublimate. In column 4, the percent gain of disease-free straws over check, estimated upon basis of stand, is found to be very considerable, particularly in the plots where the mercury was combined with either the nickel or the copper salt. There is no reason to believe that the germination of seed was impaired thru the use of any of these mixtures, but on the other hand, there is considerable evidence that there was marked stimulation by some of them.

This work was repeated for further confirmation and enlarged upon in 1925, with similar results. The combinations of copper and mercury salts gave satisfactory control in all instances. The tests of this season were under entirely different conditions from those of 1924. In the spring of 1924 a long rainy season followed after the plots were sown, while in 1925 a very severe drought occurred during the same period. Germination was very slow in all plots with the result that the yields were severely reduced. The contrasting conditions under which these treatments were employed with equally good results in both cases, lead us to believe that they are reliable for oat smut control.

TABLE SHOWING RESULTS OF SEED TREATMENT FOR CONTROL OF OAT SMUT IN 1924

	Treatment	Percent smut	Percent stand on basis of check	Percent disease-free straws in terms of stand	Percent gain or loss of disease-free straws over check
1	Check, no treatment	32.00	100.0	68.0	−32.0
2	Formaldehyde, sprinkling method	0	87.5	87.5	+19.5
3	Formaldehyde diluted (1-1 with water	.01	97.2	96.2	+2[illegible].2
4	Formaldehyd diluted (1-10) with water	.007	94.2	93.2	+25.2
5	Copper carbonate powder	4.60	105.3	100.4	+32.4
6	Copper carbonate plus mercuric chloride	.05	101.5	101.3	+33.3
7	Copper sulphate (not anhydrous)	11.4	102.0	90.3	+22.3
8	Copper sulphate plus mercuric chloride	.7	112.7	111.9	+43.9
9	Nickel carbonate	3.6	100.7	97.1	+29.1
10	Nickel carbonate plus mercuric chloride	.5	111.0	110.4	+42.4
11	Copper acetate	8.0	107.0	98.4	+30.4
12	Copper acetate plus mercuric chloride	.5	116.0	115.6	+47.6

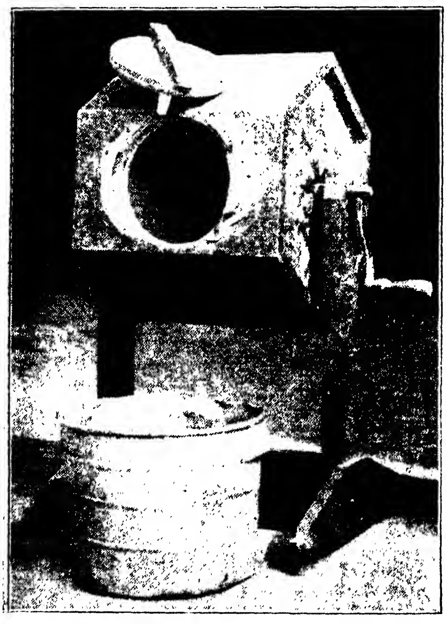
In the tests of 1925 an attempt was made to determine to what extent the proportions of the original mixtures could be varied, or to what extent inert fillers could be used to reduce the cost of these preparations without reducing their fungicidal value. In the work, so far, we have not succeeded in varying the composition in any way whatever without reducing considerably the value of the mixtures as fungicides. Even when two parts of a copper salt to one of the mercury were used there was a marked increase in the percentage of smut.

A field test of about 20 acres under conditions of ordinary farm practice was made on the farm of George Reed, near Shreve, Ohio. The degree of smut control in this field test was in close agreement with the plot work. The dust preparations employed and the results obtained follow:

TREATMENT	PERCENT OF SMUT
1. Copper carbonate 1 part Mercuric chloride 2 parts	2.0
2. Copper sulphate 1 part Mercuric chloride 2 parts	0.3
3. Copper acetate 1 part Mercuric chloride 2 parts	0.2
4. Check—not treated	18.0

METHOD OF APPLICATION OF FUNGICIDES

Much depends upon the method of application. This is important, not only from the standpoint of thoroness of application, thereby insuring complete disease control, but also from the standpoint of ease and convenience of treatment. All fungicides are poisons, varying according to the nature of the compound in degree of toxicity. Formaldehyde, a gas in solution, is often found to have an irritating effect upon the membrane of the throat and nasal passages. This effect is also experienced in the use of dusts. The copper dusts, particularly copper-carbonate and copper-sulphate, have an irritating effect, which appears to be somewhat more marked when they are combined with corrosive sublimate. It is, however, of a transient nature and need not serve as a deterrent to the use of any fungicide in the dust form.



This type of rotary churn is convenient for treating grain

How to use dusts.—The most efficient and convenient method for treating grain with dusts is in some form of closed container. The small rotating churn shown in accompanying figure was used in the greater part of the work included in this report. A half bushel of grain could be treated at one time, requiring about two minutes for thoroly coating the seed.

In an earlier report it was suggested that treatment be made by shoveling over the grain spread upon a floor until the powder was thoroly mixed with it. While effective results can be obtained from this method it will be found, on the

whole, very unsatisfactory, because much of the fungicide will be lost and the dust arising unpleasant to inhale. Later experience has demonstrated the value of using a closed container. Some have used a cement mixer and have found it quite suitable. It has one disadvantage in not being entirely closed, thus allowing considerable dust to escape during the mixing. A barrel can very easily be adapted for this work. Several strips should be fastened on the inside to catch the grain and allow it to fall over and thoroly mix, as the container is being rotated.

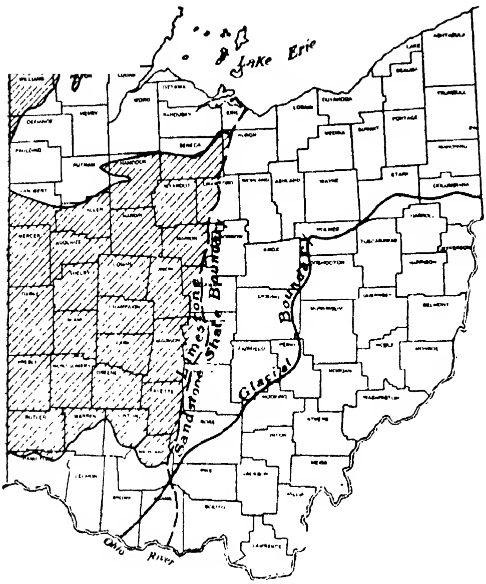
How much powder to use.—We have not seen fit to change our former recommendations of 3 ounces (3 heaping tablespoonfuls) of powder for each bushel of grain treated. Within reasonable limits the cost of the dust is a minor matter in the control of grain smuts. Two ounces of a finer grade of powder may be found to be sufficient if the seed carry only a small percentage of smut and if longer time be given to the treatment. In our own tests we have always secured better smut control from the use of 3 than from 2 ounces of dust. Best results have always been obtained with the copper-acetate and mercuric-chloride mixtures. These were followed in close order by the copper-sulphate and copper-carbonate preparations. The cost of these mixtures is relatively high, likely about one dollar per pound.

In treating cereal grains we may either treat the entire quantity of seed to be sown, if it is known to require treatment, or treat only sufficient seed to sow a seed plot of five acres or less. Relatively more care can be given to a small than to a large quantity of grain, thereby insuring a more complete smut control. The crop thus produced from the treated seed may be used without further treatment for seed for the crop of the following season. In this way losses from smut may be reduced to a negligible quantity, at a small cost for the treatment. This is by no means a new idea. Some of our best grain growers follow this practice consistently.

GLACIAL LIMESTONE SOILS OF OHIO

G. W. CONREY

The area of glacial limestone soils includes all of the western half of the State except the "lake plain" in the northwest. In the present discussion the area of very old glacial limestone soils in the Cincinnati region is also excluded. The region under consideration, which includes the famous Miami Valley, has within its borders some of the most fertile agricultural lands of the State.



Showing glacial limestone area
(See also frontispiece)

Origin of the soils.—The upland soils of the region have been formed from the weathering of the mantle of glacial drift which everywhere covers the land surface. This drift varies greatly in thickness, ranging from 1 or 2 feet in places to a maximum of over 100 feet elsewhere. The average is about 50 feet.

The underlying rocks of the region are for the most part limestone, hence the soil-forming material is largely of limestone origin. Only a small percentage of foreign rocks, brought from some distance to the north by the glacier, is included in the drift. In parts of the region black shale, which outcrops locally, has been mixed with the limestone giving a much heavier soil forming material.

Topography and drainage.—The surface of the upland varies from almost level to rolling. Extensive areas appear to be almost level, but elevations slightly above the general level of the country give a gently undulating topography.

Areas with a gently rolling to rolling topography exist in various parts of the region.

The natural drainage of the level upland areas is poor, and tiling has been resorted to for profitable crop production. The more

rolling areas have good surface drainage, and fair to good underdrainage, depending upon the character of the subsoil. On some of the rolling, gravelly areas underdrainage may be excessive.

Why soils differ.—Altho derived from glacial limestone material of fairly uniform character, marked differences in soil characteristics have developed due to differences in the topography and natural drainage under which the soil material has existed since its deposition. These differences are reflected in the agricultural value of the land.

Organic matter.—Vegetation early covered the surface of the land, with a resulting accumulation of organic matter in the soil. As most of the region supported a heavy timber growth, the organic matter has been derived largely from leaf mold, hence for the most part the organic layer is shallow. In certain areas of a low, wet nature a heavy grass vegetation, typical of a wet prairie, gave rise to an organic layer of considerable depth (12-18 inches).

Various soil colors.—As a result of the various conditions of topography and drainage, the soils are of different colors. On the higher lying, well-drained areas, with good aeration, the soils are reddish-brown, brown, or yellowish-brown in color. On the low-lying, poorly drained areas, where greater amounts of organic matter have accumulated, the soils are dark gray, gray-black to black. Between these extremes are gradations thru gray-brown and gray.

The subsoils also have developed characteristic colors. The well-drained subsoils are brown, reddish-brown, or yellowish-brown. Poor underdrainage results in mottled subsoil colors, varying from yellowish-brown and yellowish-gray with fair drainage, to bluish-gray, gray, and yellow with very poor drainage.

Color in soils serves as an excellent basis for soil distinctions; for it furnishes an indication as to the conditions under which the soil has existed during its development, and from it many of the soil properties can be inferred.

Soils have been leached.—In the process of soil development the more soluble constituents are gradually taken into solution and in part carried away from the soil in the drainage waters. Lime, especially in the form of calcium carbonate, is subject to loss from the soil. The depth to which it has been removed serves as an index to the extent of leaching. As lime is removed an acid condition tends to develop, hence the reaction of the various layers of the soil is an important consideration.

SOILS OF THE GLACIAL LIMESTONE REGION

	Deep glacial soils						
Color of soil	Brown	Brown	Brownish-gray	Gray	Brownish-gray	Dark gray	Gray black
Color and character of subsoil	Yellowish-brown Stratified sand and gravel	Reddish-brown	Mottled yellowish-brown and yellowish-gray	Mottled gray and yellowish-brown	Mottled yellowish-gray and yellowish-brown Calcareous at 18 to 22 in.	Mottled bluish-gray and yellowish-brown	Mottled bluish-gray and yellow
Topography	Sloping rough and broken	Gently rolling to rolling	Gently rolling	Undulating	Undulating	Level	Level
Natural drainage	Excessive	Good	Fair to good	Fair to poor	Fair	Poor	Very poor
Series	Rodman	Bellefontaine	Miami	Crosby	Conover	Brookston	Clyde
Important textures	Gravelly loam	Loam silt loam	Silt loam silty clay loam	Silt loam	Silt loam	Silty clay loam	Silty clay loam

SOILS OF THE GLACIAL LIMESTONE REGION

	Shallow glacial soils (over limestone)			Terrace soils (second bottom)			Flood plain soils (first bottom)	
Color of soil	Brown	Brownish-gray	Dark gray	Brown	Dark brown	Gray-black	Grayish-brown	Gray-black to black
Color and	Reddish-brown	Mottled gray and yellowish-gray	Mottled bluish-gray and yellowish-brown	Reddish-brown	Dull yellowish-brown	Mottled bluish-gray and yellowish-brown	Light brown	Mottled bluish-gray and yellowish-brown
character of subsoil	Limestone at 20 to 36 in.	Limestone at 20 to 36 in.	Limestone at 30 to 36 in.	Stratified sand and gravel at 2 to 5 ft.	Stratified sand and gravel at 2 to 5 ft.	Stratified sand and gravel at 2 to 5 feet		
Topography	Undulating	Undulating	Level	Level	Level	Level	Level	Level
Natural drainage	Good	Poor	Very poor	Good	Fair to good	Very poor	Fair to good	Very poor
Series	Milton	Randolph	Millsdale	Fox	Waukesha	Abington	Genesee	Wabash
Important textures	Silt loam	Silt loam	Silty clay loam	Loam silt loam	Silt loam	Silty clay loam	Silt loam	Silt loam silty clay loam

Development of a heavy layer.—Along with the loss by leaching of soluble constituents, there is a movement downward of the finer particles of the soil with a tendency for the development in the subsoil of a heavy layer, or as it is sometimes called a "hard pan" layer, which under some conditions may become so tight and impervious as to hinder the movement of water thru the subsoil. The most favorable conditions for the development of such layers are intermediate in drainage where the soil is alternately wet and dry.

The soil profile.—As a result of the operation of the natural processes of soil development there is produced a gradation in soil characteristics from the surface downward to the slightly weathered parent material, which is shown in distinct layers, or horizons, within the soil. Differences in such characteristics as color, structure, texture, reaction, etc. furnish a basis for soil differentiation and classification.

SOILS OF THE GLACIAL LIMESTONE REGION

A. Deep Glacial Soils

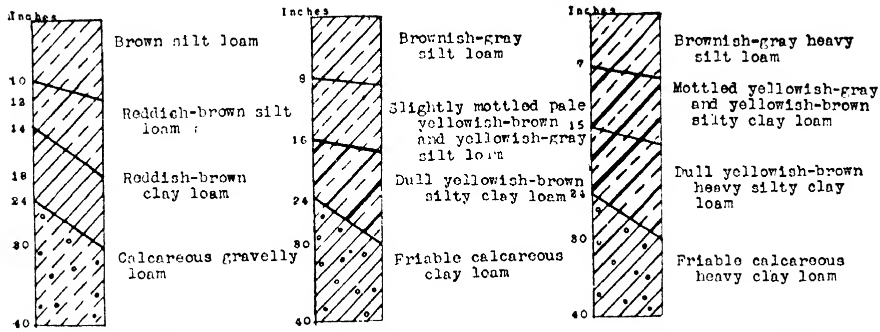
Based on differences in soil characteristics, seven different soil series have been recognized in the upland area of this region: Rodman, Bellefontaine, Miami, Crosby, Conover, Brookston, and Clyde. Of these the Rodman and Bellefontaine are naturally the best drained, and Clyde the poorest.

Rodman series.—The Rodman soils have brown to reddish-brown surface soils and gravelly, sandy subsoils. They are confined to very gravelly knolls and slopes, and the topography is usually sloping to rough and broken. Drainage is excessive. Such areas are usually of little agricultural value, except for spring and early summer pasture. Rodman gravel, gravelly fine sandy loam, and gravelly loam are the most important types. These soils are very limited in extent.

Bellefontaine series.—The surface soils are brown and the upper subsoils reddish-brown to chocolate-brown. The lower subsoil below 24 to 30 inches is a highly calcareous gravelly loam. These soils occupy rolling areas and are naturally well drained. They are commonly spoken of as "red soil" or "sugar tree land". The most extensive areas are in Logan, Champaign, and Clark Counties, where the brown soils cover a large part of the rolling uplands. These soils are usually well supplied with lime, and are ideal for alfalfa. They are also considered among the best grain soils of the region. Bellefontaine loam and silt loam are important types.

Miami series.—The Miami series includes brownish-gray soils with a pale yellowish-brown subsurface. The subsurface is slightly mottled, with yellowish-gray in the more level areas. The upper subsoil from 16 to 24 or 30 inches is a dull yellowish-brown streaked with rust-brown iron stains and is commonly much heavier than the layers above or below. This is underlain by a friable calcareous clay loam.

This series, which is the most extensive in the region, includes two important types: Miami silt loam and silty clay loam. The latter, which is heavier, probably contains a considerable admixture of shale material. The silt loam is characterized by a silt loam surface soil to about 8 inches, a silt loam subsurface to 16 inches, and a heavy layer below this depth. The silty clay loam has a heavy silt loam surface soil, a silty clay loam subsurface from 8 to 16 inches, and a heavy layer below. The outstanding difference is in the subsurface from 8 to 16 inches, which is much heavier in the silty clay loam than in the silt loam.



Bellefontaine silt loam — Miami silt loam — Miami silty clay loam

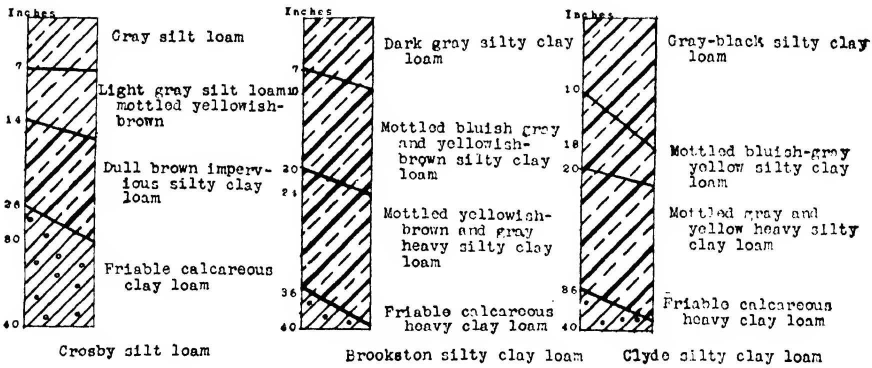
Miami soils exist in all parts of the region, where they occupy undulating to gently rolling areas with fair to good surface drainage. The more level areas will require tiling for the most profitable crop production.

Altho derived from calcareous glacial material, the lime has largely been leached from the surface soil, which is beginning to show a slight degree of acidity. Light applications of lime undoubtedly would prove to be profitable on certain areas of the Miami soils. These acid areas can only be located by tests for soil acidity on individual fields. These soils are considered to be good small grain and fair corn soils.

Three of the State Experiment Farms are located on Miami soils. The soil on the Southwestern Test Farm near Germantown

is Miami silt loam; on the Madison County Farm, Miami silty clay loam; on the former Northwestern Test Farm near Findlay, Miami silty clay loam.

Crosby series.—The surface soil of the Crosby series is gray, the subsurface light gray mottled with pale yellowish-brown; the upper subsoil from 16 to 24 or 30 inches, a dull brown streaked with rust-brown iron stains and very heavy and impervious; and the lower subsoil, a friable calcareous clay loam. The Crosby silt loam, which is the most important member of the series, has a gray silt loam surface, and a light gray, slightly mottled with pale yellowish-brown silt loam subsurface. The upper 2 or 3 inches of the surface horizon may be almost devoid of mottling, but below this the mottling increases with depth. This is underlain by 8 to 12 inches of a heavy, compact, impervious silty clay loam which greatly hinders the movement of soil moisture.



These soils occur on gently undulating areas, only slightly above the associated lower lying areas of dark soils. Not infrequently they occur in areas of only a few acres. The names "white clay land" and "beech land" are commonly used for the Crosby soils. The surface drainage is fair, and the underdrainage poor, as a result of the heavy subsoil or "hard pan" layer. Tile drainage is very essential

Crosby soils are almost invariably acid in both the surface and subsurface horizons. Clover failures are common on these so-called "clay spots". The more general use of limestone is desirable.

In common with all gray soils of the region, the Crosby silt loam is naturally poorly underdrained, acid, and generally low in natural fertility as compared with other soils of the area under consideration. Crosby silt loam is one of the soils on the Miami County Experiment Farm.

Conover series.—This series includes soils with a brownish-gray surface soil, mottled gray and yellowish-brown subsurface, dull brown heavy upper subsoil, and friable calcareous clay loam lower subsoil at 18 to 22 inches. The surface differs from the Crosby in the darker surface soil, and from both the Crosby and Miami in the shallow depth to the calcareous subsoil. The series occupies gently undulating areas, and has fair surface and under-drainage. Conover silt loam, the only type of this series which has been recognized, is of very limited extent.

Brookston series.—The surface soil of the Brookston series is a dark gray to dark brownish-gray to a depth of 7 to 10 inches. The upper subsoil is a bluish-gray mottled yellow and yellowish-brown. Below 18 to 24 inches the subsoil is mottled yellow and bluish-gray. Friable calcareous clay loam occurs below 30 to 40 inches. The lack of very heavy, impervious layers in the subsoil is characteristic and facilitates drainage. When wet the surface soil has a black appearance, hence the name "black land". Sometimes the name "elm land" is applied to this soil.

The Brookston soils occupy low areas and depressions thruout the upland. The topography is level and the natural drainage poor.

Brookston silty clay loam, the most extensive member of the series, is one the most important corn soils of western Ohio. It is seldom acid, hence, where properly drained, is well adapted to red clover and alfalfa. This soil type occurs on the Miami County Experiment Farm.

Clyde series.—The Clyde soils are dark gray-black to a depth of 10 to 18 inches. The upper subsoil is bluish-gray to gray streaked with yellow and the lower subsoil is mottled gray and yellowish-brown. As with the Brookston, there is little or no evidence of a heavy layer in the upper subsoil. The friable calcareous clay loam usually occurs at 36 to 40 inches. The Clyde soils are darker than the Brookston and the organic layer is deeper. They are commonly spoken of as "black land."

These soils occupy low, level areas, and are naturally very poorly drained. They are extensively distributed thruout nearly all parts of this region. The most extensive type is Clyde silty clay loam, which is recognized as one of the best corn soils of the State.

B. Shallow Glacial Soils (over limestone)

In parts of the area the mantle of glacial material rests on limestone at a depth of 20 to 30 inches, giving soils which are quite distinct from the deep glacial soils of the region. They are especially characterized by a heavy clay horizon just above the bed rock,

which is probably in part residual from the limestone. Three series have been recognized: the Milton, Randolph, and Millsdale. The total area is very limited.

Milton series.—The surface soils are brown to reddish-brown, and the subsoils are reddish-brown sticky plastic clay. This rests on limestone at 20 to 36 inches. The topography is level to gently undulating, but the drainage is good. The soils as a rule are very fertile, and, being well supplied with lime, are excellent for alfalfa. Milton silt loam is an important type.

Randolph series.—The surface soils are gray to brownish-gray and the subsurface mottled pale yellow and light gray. The upper subsoil is a dense yellowish-drab to dull brown silty clay loam to silty clay. Bed rock occurs at 20 to 36 inches. The surface is almost level and the drainage poor. A slight degree of acidity is common in the surface soil.

Randolph silt loam is the common type, and it resembles the Crosby soil both in physical characteristics and in composition. Because of the shallow depth to bed rock much of the type is difficult to tile drain.

Millsdale series.—The surface 7 to 9 inches is dark gray to gray-black, and the subsoil bluish-gray streaked with yellow. The proportion of yellow increases with depth. Friable calcareous clay loam occurs at 24 to 30 inches and limestone bed rock at 30 to 36 inches. The topography is level and the natural drainage very poor. Where the soil can be tiled adequately, it has about the same agricultural value as the Brookston soils. Millsdale silty clay loam is the most important type.

C. Terrace Soils

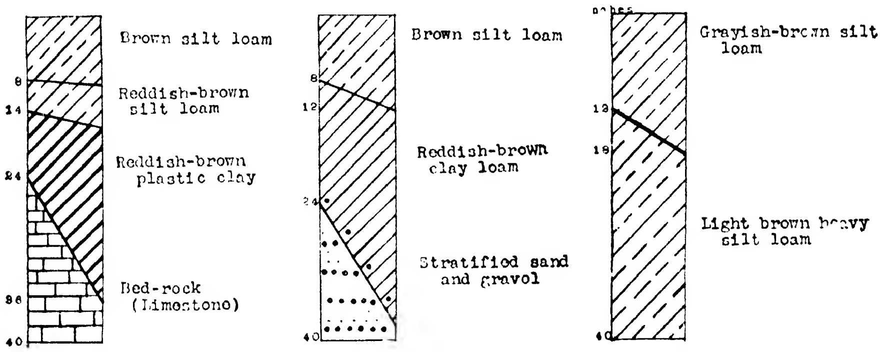
These soils are characterized by layers of stratified sand and gravel in the lower subsoil. They are confined to terraces in the valleys of present streams or former streams, and are commonly spoken of as "second bottom lands". They have been deposited by streams coming from the melting ice which existed in the region during the glacial period. There are three series: Fox, Waukesha, and Abington. The total area is limited.

Fox series.—The surface soils are brown to reddish-brown and the subsoils reddish-brown. At 2 to 5 feet the substratum consists of stratified sand and gravel made up largely of limestone material. The topography is level and the drainage excellent. In some areas, where the gravel is within 12 to 18 inches of the surface, the soil

tends to be droughty. These soils are very fertile. Being well supplied with lime, they make ideal alfalfa soils. Fox loam and silt loam are important types.

Waukesha series.—The surface soil is a dark brown, and is underlain by a dull yellowish-brown subsoil. Stratified sand and gravel occur below 2 to 5 feet. The topography is level and the drainage fair to good. Where the depth to gravel is great, tile drainage may be desirable.

These soils are generally recognized as being very fertile. They are commonly not acid, hence are well adapted to alfalfa where the drainage is good. Waukesha silt loam is an important type.



Milton silt loam | Fox silt loam | Genesee silt loam

Abington series.—This series has gray-black surface soils and mottled bluish-gray and yellowish-brown subsoils. Gravel and sand occur at 2 to 5 feet. The topography is level and the natural drainage very poor. Tile drainage is necessary on most of the areas, altho open ditches may serve to remove the waters from the underlying gravels and in this way furnish adequate drainage for a considerable proportion of these soils. Abington silty clay loam, when adequately drained, makes an excellent corn soil. The surface color closely resembles that of the Clyde. There are slightly lighter areas of terrace soils in the region, similar to the Brookston in color, for which a series name has not yet been selected. Such areas are very limited.

D. Flood Plain Soils

These soils exist as first bottom lands and are subject to annual overflow. They are recent alluvial soils, deposited by the present streams as wash from the surrounding upland glacial limestone soils. They have been included in two series: Genesee and Wabash.

Genesee series.—The Genesee soils are grayish-brown to dark brown to 12 or 18 inches, underlain by a slightly lighter subsoil which continues to 36 inches or more with little change. These soils show little tendency toward a differentiation into definite layers, or horizons, but they do show variation in texture from place to place. The topography is level, except where old stream channels form low depressions. The drainage is good to poor; many areas could be improved by tiling. All of the soils are subject to overflow. Some areas are protected by dykes which keep the waters off during moderate floods.

The Genesee soils are very fertile. Corn is the most important crop. Large areas are used for permanent pasture. Genesee silt loam is an important type.

Wabash series.—The Wabash series includes soils with gray-black to black surface soils of 12 to 18 inches depth, and mottled bluish-gray and yellowish-brown subsoils. The surface is flat and natural drainage very poor. The land is subject to overflow. With adequate drainage these make splendid corn soils. The undrained land is chiefly of value for permanent pasture. Wabash silt loam and silty clay loam are the most important types.

CERTIFIED CLOVER SEED

L. E. THATCHER

Ohio farmers are now assured of a reliable adapted clover seed of known origin. The Ohio Seed Improvement Association thru its authorized dealers has worked out a plan for the certification of clover seed. The Association will make the inspections, furnish the certification tags and supervise the sealing of the bags; while the authorized dealer will handle the cleaning, packing, and selling of this seed. The guarantee of origin will be backed by original growers or local dealer's affidavit. The records tracing each lot back to its point of origin will be kept on file. The purity standard is 99.25 for red clover, absolutely free from dodder, Canada thistle, and quack grass and commercially free from other noxious weeds.

Much imported seed is unreliable. Italian seed especially is of little value for planting in Ohio. Ohio grown seed has consistently led all others in yields and winter hardiness. To insure a good stand of clover plant only guaranteed origin, hardy, adapted seed.

PROPAGATION OF GRAPE VINES

DEPARTMENT OF HORTICULTURE

Grapes are usually propagated by hardwood cuttings; altho layering from an adjacent vine is often resorted to for replacement of missing plants in a vineyard.

Propagation methods for starting grape plants from cuttings vary and are accompanied by different degrees of success. Favorable soil and moisture conditions in the spring often insure complete success with cuttings placed upright in the garden without the callousing treatment. Another method is to plant cuttings under glass jars. If the wood is cut as in B or C (see figure) the cuttings may be planted according to the methods mentioned. However the results will be uncertain.

Cuttings to be rooted on a commercial scale are often collected in winter or early spring, tied in bundles, labeled, and buried several inches deep and the surface of the ground covered with a layer of straw to retain heat and prevent freezing. After six weeks many of the cuttings will have formed a callous on the basal end from which roots start to grow. They are then placed 6 inches apart in rows in the nursery.

The following method used by many propagators gives the most uniform success. Cuttings are always selected from medium sized canes grown the previous summer. Their length ranges from 8 to 12 inches depending upon the length of the nodes as each cutting usually has three buds. The cuttings are usually taken in winter or early spring. Those taken in the spring should be carefully selected to exclude canes damaged by severe weather. Whether the cuttings are taken in winter or early spring, it is very essential that they be immediately placed in the callousing bed or other protection to prevent drying out.

An ordinary cold frame serves as an excellent callousing bed. The cuttings, which have been tied in bundles, are placed in a vertical position with the top ends in the soil, and covered with sand or sandy soil to the depth of two inches. The glass protection warms the layer of soil over the cuttings encouraging a callous growth. The buds which are buried deeper remain cool and dormant until planted in the nursery. An occasional watering of the soil will prevent excessive drying.

The cuttings are allowed to remain in the cold frame four to six weeks, or until the second week in April, when many small roots will have started from the callous. They are then planted with the upper bud at least 1 to 2 inches above ground, and are spaced 6 inches apart in the row. Frequent cultivation is necessary until August.

The process of layering is very simple. In early spring a section of cane attached to the parent vine is covered with 4 to 6 inches of earth. The farther end, which is turned abruptly upward, furnishes the buds which produce the canes of the new plant. The new plant is cut from its parent the following spring. This method of propagation is excellent where only a few plants are desired, provided a rich earth can be easily prepared in which to make the layering. Layering should not be attempted in thin, wornout soil.

Grape cuttings: A, cut too far from bud for quick root development. B, correct position of cut. C, mallet cutting, which is often used. D, Grape cutting after several months' growth

THE POTATO SITUATION

R. F. TABER

The potato crop is ordinarily considered one of the real speculative crops in the farming business. Last year the potato growers, particularly in the producing regions far distant from market, secured very little for their crop, while this year the man who has potatoes, and has in spite of the weather been able to dry them, is "sitting pretty" financially.

The potato crop for this year according to the government estimate made November 1 is 346,503,000 bushels. The crop last year was 455 million bushels, while the average production during the last five years has been 418 million bushels. In view of the present crop shortage, it is interesting to see what the normal change in price during the winter months has been in the past and what normally happens with crops as short as the present one.

THE EFFECT OF LOW PER CAPITA PRODUCTION ON POTATO PRICES; AVERAGE PRICE IN CENTS PER BUSHEL

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1819-1913	61	62	65	67	69	74	74
Years of low production	64	75	79	84	87	95	106

The average gain in prices from October to April for the period was 13 cents per bushel, or 25 percent. With crops of about three bushels per capita of our population, as is the case this year, the average gain in price during the winter was about 60 percent.

Some potatoes will doubtless be shipped in from Canada, which normally produces around 12 bushels per capita as compared to 3.6 bushels in the United States. Many potatoes in Canada are fed to livestock. The Canadian crop is about 35 percent below normal this year which to a great extent eliminates this menace to farm prices. If all of Canada's surplus above normal were shipped to the United States it would not make up the deficit here. Sweet potatoes are also scarce this year as the crop was about 20 percent below normal.

The rapid increase in price during the fall has attracted more than the normal run of potatoes to market, which should be an encouraging sign for prices later. From the first of October to the middle of November 12 percent more potatoes were received at the principal markets this year than last.

If history repeats itself, and potato prices remain at a fairly high level during the winter, there will be an abnormal interest in potato raising next spring. If the usual happens they will be well planted, well fertilized, and well cared for. In 23 years out of the last 26, statistics show that a poor crop is followed by a crop above normal the next year, while only three times was a poor crop followed by another poor one or a big crop by a big one. The farmer's best policy in the potato business, unless he be gifted with unusual speculative instinct, is to plant about the same acreage year after year and give them good care and attention.

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

The outstanding change since August in prices of interest to the Ohio Farmer is the decline in the level of prices received for farm products. From a level of 166 in July the price index for Ohio farm products declined to 151 in October and 157 in November. Lower prices for corn and hogs, which comprise around 30 percent of the income of the Ohio farmer, was the chief cause of the decline. Milk did not show the usual seasonal advance. This lower price level has caused the purchasing power of the Ohio farmer to slip back from the higher than prewar level which it attained in June, 1925. The large corn crop, however, will help to improve conditions by making available for sale a larger than normal crop either as grain or livestock. The large crop of corn, oats, and cotton would indicate low feed prices, which is of interest to the Ohio farmer who buys for feed.

On the demand side, city wages seem to be mounting, the volume of sales at retail is good. As a whole all interests seem to be looking forward to a period of prosperity for the city works, which would mean a good demand for farm products.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Farm wages	Non-agriculture products	Farm prices U. S.	Farm prices Ohio	Ohio farm purchasing power
1913..........	102	....	104	105	100	104	102
1914..........	100	100	102	97	102	105	105
1915..........	103	101	103	101	100	106	103
1916..........	130	114	113	138	117	121	93
1917..........	181	129	140	182	176	182	100
1918..........	198	160	175	188	200	203	103
1919..........	210	185	204	199	209	218	104
1920..........	230	222	237	241	205	212	92
1921..........	150	203	164	167	116	132	88
1922..........	152	197	145	168	124	127	84
1923..........	156	214	166	171	135	134	86
1924..........	152	218	165	162	134	133	87
1924							
January.....	154	219	159	177	137	125	81
February.....	154	218	....	178	136	129	84
March.....	153	222	....	179	131	127	83
April.....	151	218	163	180	130	125	83
May.....	150	217	....	171	129	127	85
June.....	147	214	....	172	130	126	85
July.....	150	213	168	169	132	125	83
August.....	152	216	....	167	139	138	91
September.....	152	221	....	167	132	139	92
October.....	155	217	170	165	138	145	94
November	155	218	....	163	137	145	94
December.....	160	222	....	162	139	148	93
1925							
January.....	163	223	156	165	146	155	95
February.....	164	220	....	177	146	155	95
March.....	164	224	....	165	151	159	97
April.....	159	218	163	162	147	158	99
May.....	158	221	....	161	146	162	104
June.....	160	220	....	163	148	165	105
July.....	163	220	168	164	149	166	102
August.....	163	222	....	164	152	163	99
September.....	163	223	....	163	144	157	96
October.....	161	225	173	162	143	151	94
November.....	....	....		164	....	157	....

NEW MONOGRAPH BULLETINS

No. 384, The Soybean in Ohio, by L. E. Thatcher, gives the status of the soybean among Ohio farm crops, its residual effect upon soil fertility, and is a manual of practical methods of growing and handling the crop.

No. 385, Blooming Period and Yield of Apples, by C. W. Ellenwood. This is a summary and study of fifteen consecutive annual records of the time of blossoming, bearing habits, dates of harvesting and ripening, and yields of varieties of apples.

No. 386, An Introductory Study of the Acarina, or Mites, of Ohio, by August E. Miller. As the title suggests, this is a technical paper on the mites found in Ohio. Some 127 species are presented, 28 of which are of direct economic importance. The discussion of each economic species includes the most practical control thus far known.

No. 387, Subterranean Aphids of Ohio, by C. R. Cutright. This technical bulletin is the result of several years research into the life history, habits, and economic control of underground aphids, or plant lice. The work includes a complete list of known Ohio species with keys for the different genera and species.

No. 388, The Striped Cucumber Beetle, by J. S. Houser and W. V. Balduf. The first part of this bulletin is a rather exhaustive paper on the life history, habits, food plants, and natural enemies of this common pest. The manner of hibernating, a much discussed topic in the past, is definitely given. The second part discusses control measures and includes a history of those used in the past. Of the elaborate series of materials given trial, one combination, calcium arsenate and land plaster applied as a dust, stood out above all others. Not only were the beetles controlled but a distinct stimulation of plant growth attended their use.

The Monograph Bulletins are sent free upon request by postal card or letter addressed to the Experiment Station, Wooster, Ohio.

The Bimonthly Bulletin

Vol. XI, No. 2 March-April, 1926 Whole No. 119

Ohio Agricultural Experiment Station

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OHIO AGRICULTURAL EXPERIMENT STATION

Wooster, Ohio, U. S. A.

PROF. H. A. GOSSARD

Born Feb. 7, 1868; Died Dec. 18, 1925

Mr. Gossard came to the Ohio Experiment Station nearly 22 years ago; the present Director preceded him but a few months. These long years of service together as heads of different departments afforded opportunity for great friendships or growing animosities. The latter could not flourish in the Gossard atmosphere. He made friends not only with the Station Staff, but with the farmers and horticulturists of the State with whom he came in contact. The efficient service which he rendered Ohio is recognized by all and will be appreciated by coming generations. Not only is his worth appreciated in the State he served so long, but the entomologists of the country at large testify to his services.

Among his co-workers let us hear from the following:

Altho a quiet man, his strength was recognized by all of the workers. Since his election as President of the Association of Economic Entomologists of America he had been very active in his plans for the coming meeting at Kansas City; and it is one of the saddest events in my experience that I shall not be able to hear his presidential address. I know that he had done a great deal of careful thinking and had conducted a very large correspondence in connection with the meeting. He was an extremely far-sighted man. I have been greatly impressed by the breadth of his views. He had ideas which, if he could have lived to put them into effect, would have been of enormous assistance to world agriculture.

L. O. Howard, Chief of Bureau of Entomology
U. S. Department of Agriculture

I first knew Harry Gossard as a student in college and close association with him thru many years has only strengthened the friendship formed at that time and my appreciation of his sterling character and his high scientific ideals have grown with the passing years.

Herbert Osborn,
Research Professor in Zoology and Entomology
Ohio State University

If it was asked of me to designate the most outstanding attribute of Prof. Gossard's professional character as brought out during the many years it was my privilege to call him chief, without a moments hesitation it would be, his utter lack of consideration for his own interests and his fatherly, kindly attitude toward those in his department. I am sure that not only those in the department at the present time but also every one who at any time in the past was connected with the department will join me when I say, Prof. Gossard was a chief among chiefs; loved, honored, and respected.

J. S. Houser
Associate Entomologist
Ohio Agricultural Experiment Station

BIMONTHLY BULLETIN

OF THE

Ohio Agricultural Experiment Station

VOL. XI, NO. 2 MARCH APRIL, 1926 WHOLE NO. 119

ALSIKE CLOVER

C. J. WILLARD*

Life history studies of legumes at the Sub-station at the Ohio State University have given considerable data on the value of alsike clover, which it seems worth while to give separately.

Alsike is frequently undervalued and considered more or less a "poor relation" among clovers, but the more one studies it the less this seems justified. Director Williams has shown in Bulletin 362, page 12, that, at Wooster as a 10-year average, alsike has outyielded red clover, mammoth clover, white sweet clover, and yellow sweet clover. Our results at Columbus have been similar. All available comparisons of alsike and red clover in the life-history studies have been collected in Table 1. Red clover was chosen for comparison because it is the standard Ohio legume. In some instances in which red clover was not available white sweet clover was chosen. All these yields were secured by harvesting square-yard plots. The roots were secured to a depth of 1 foot.

An outstanding feature of this table is the remarkable uniformity of the weight of roots of alsike and of red clover. The root systems of the two clovers appear quite different. Red clover has a much branched but distinct tap root, while alsike has a tap root so very greatly branched into side roots as to give the impression of a fibrous root system. For this reason it is usually thought that alsike has a smaller root system than any other clover, and one of the surprises of the investigation was the fact that it is not materially inferior to red clover in this respect. The roots of alsike do not usually penetrate as deep in the soil as those of red clover, but even here the difference is not so great as is popularly supposed.

*Department of Farm Crops Ohio State University.

The nitrogen content of both the roots and tops of the two clovers at corresponding stages is very similar. Both are inferior in this respect to sweet clover and alfalfa. The two records in the spring of 1924 are of especial interest. This test was on black soil in a very wet season. June 18 the sweet clover was 39 inches high, while the alsike was lodged to about 15 inches, yet the top growths were nearly equal. The small root growth of the alsike under these conditions was noteworthy.

TABLE 1.—Comparative Yield and Nitrogen Content of Alsike and Red or (*) Sweet Clover

Date and method of seeding	Date of harvesting	No. plots	Pounds per acre, air dry				Percent of nitrogen in			
			Tops		Roots		Tops		Roots	
			Red	Alsike	Red	Alsike	Red	Alsike	Red	Alsike
1921	1921									
April – wheat........	Nov. 8	3	2510	2170	880	1100	......	......	......	......
1922	1922									
March 25 in early oats	Aug. 25	3	2130	1730	610	580	.....	......	....	......
March 25 in late oats..	Aug. 25	3	1580	1010	480	340	......	......	......	.....
March 25 Wheat.......	Aug. 25	3	950	1190	240	450	......	......	......	......
April 6 Oats...........	Sept. 6	2	1070	1120	330	220	......	......	1.93	1.97
April 6 Oats...........	Sept. 28	2	1950	2280	510	600	2.92	2.61	2.43	2.57
	1923									
April 6 Oats...........	April 1—7	2	660	1000	980	1320	3.40	3.56	3.22	3.08
April 6 Oats...........	Apr. 24—26	2	1800	1900	1050	1000	3.16	2.83	2.43	2.42
April 6 Oats...........	May 10—17	2	3810	3310	1410	1040	.....	......	......	......
April 6 Oats...........	May 24—31	2	5600	5650	1250	1280	2.89	2.71	2.01	2.13
April 6 Oats...........	June 14—16	2	4320	5180	1100	930	......	.....	1.93	1.93
April 6 Oats...........	July 2—7	2	4580	4480	840	520	......	......	2.00	1.92
July 28—alone.........	April 12	1	*140	450	*540	610	*4.50	4.00	*4.50	3.45
July 28—alone.........	May 1	1	*630	1070	*370	540	*4.53	3.54	*2.46	2.69
July 28—alone.........	May 19	1	*1850	2320	*500	1000	*3.32	3.30	*1.95	2.39
July 28—alone.........	June 2	1	*3710	4620	*520	780	*2.78	2.41	*1.54	2.23
July 28—alone.........	June 23	1	*6390	6130	*660	690	......	.....	*1.06	2.00
July 28—alone.........	July 12	1	*8120	4810	*600	370	......	......	*1.23	2.02
1923	1924									
April 20 oats	April 19	1	*560	780	*2150	440	*4.34	3.63	*4.38	3.61
April 20 oats	June 18—20	1	*5450	5080	*1060	430	......	......	*2.13	1.97
1924										
April 12—oats.........	Nov. 7	1	1190	880	810	800	2.84	3.02	2.76	2.94
	1925									
April 12—oats.........	April 11	1	760	1070	910	710	2.65	2.69	2.11	2.48
April 12—oats.........	May 9	1	2330	2440	1090	1220	.....	....	2.20	2.42
April 12—oats.........	June 6	1	3790	3770	1170	1030	.....	....	2.19	2.15
April 12—oats.........	July 3	1	3840	2870	1170	880	......	....	2.20	2.25

*White sweet clover: no red clover available for comparison.

A notable characteristic of alsike is its earliness. It starts active growth earlier in the spring than any other clover. This was evident in a field study and is brought out in the table by the fact that in all the early April harvests the weight of alsike tops is greater than that of any of the other plants. It is also noticeable that, in general, alsike reached its largest yield of hay either late in May or early in June and lost in yield after that time. This was probably due to the death and loss of the leaves and the leaching of dead leaves by rain. This early maturity makes alsike somewhat undesirable to mix with timothy, since it is ready to cut before the

timothy is even coming into head. If, however, this mixture is cut at this early stage it makes a beautiful hay of high feeding value and a good aftermath may be secured. It is usually said that alsike does not make a second cutting as red clover does; but several times these experiments have suggested that if alsike were cut early enough instead of being cut at the same time as red clover, it would make an excellent second cutting.

Alsike clover hay contains a good percentage of leaves and, as with all legume hays, the leaves are by far the most valuable part of the feed. This is brought out in Table 2.

TABLE 2.—Percentage of leaves and stems and of protein in Alsike Clover

Date of harvesting	Leaves	Stems	Crude protein in		
			Leaves	Stems	Total hay
	Pct.	*Pct.*	*Pct.*	*Pct*	*Pct.*
June 18, 1924	53.3	46.7	25.0	13.2	19.5
May 20, 1925	55.9	44.1	24.0	14.3	19.7
May 31, 1925	50 7	49.3	19.6	13.5	16.6
June 2, 1925	56.7	43.3	....	....	....
June 10, 1925	62.3	37.7	20.2	9.2	16.1
June 15, 1925	56.6	43.4	18.6	8.6	14.3
June 22, 1925	67.7	32 3	17.7	8.0	14.6

"Leaves" in this table includes flowers and seeds. The year 1925 was dry and the growth extremely short, so the percentage of leaves is probably higher than it would be in a moist season.

As a crop for Ohio alsike has several outstanding good qualities. It will endure poorly drained soils better than any other legume. It will even grow with its roots submerged, a condition which kills red clover or alfalfa. It is also less sensitive to acid soil conditions than any other common Ohio legume. One of the factors in the increasing acreage of alsike has been the general increase in soil acidity in the soils of the State under continued cultivation. Alsike is markedly winter resistant, winter-killing being decidedly unusual. Due to the nature of its root system alsike is also much less subject to heaving than sweet clover, alfalfa, or red clover.

A seeding of alsike is much less expensive than a seeding of red clover. Usually, as now, the seed costs less per pound than red clover, and a pound of alsike will seed as much ground as 1½ to 2 pounds of red clover. A pound of alsike contains about 700,000 seeds, one of red clover only about 250,000, so that with only half as many pounds sown per acre alsike may produce a thicker stand than red clover.

There seems to be no problem of regional adaptation with alsike as there is with various strains of red clover. So far as we know, alsike seed from one source is as good as that from any other, while much red clover seed on the American market is poorly adapted and disappointing in its results. Alsike is not subject to the diseases which have made red clover so uncertain in many sections, and it has no important special insect enemies. The alsike seed crop is more certain and usually larger than that of red clover. Northwestern Ohio is one of the important alsike seed-producing sections of the United States. Alsike has a slight tendency to be perennial and lasts longer in pastures than red clover. However, as usually grown in Ohio meadows it is essentially a biennial crop.

The two most serious objections to alsike in Ohio are its lodging habit and its early maturity. The plant is very weak stemmed and it is not unusual to find stems 4 or 5 feet long lodged down to a height of 12 to 14 inches. This of course results in death and decay of the lower leaves and gives a tangled sodden mass of stems, difficult to cut and cure. For this reason it is seldom sown alone except for seed. The best time to cut alsike for hay, which is about June 5 to 10 in the latitude of Columbus, is a time when it is difficult to cure hay because of weather conditions and when farmers are usually too busy with the first cultivation of corn to want to make hay.

Despite its good qualities, therefore, alsike is seldom used where other clovers will grow satisfactorily; but it unquestionably deserves higher repute than is ordinarily given it. Its largest place in Ohio is in mixtures. Wherever red clover is in the least uncertain some alsike should be included in the seeding to insure a stand of clover whether the red clover succeed or not. It is also desirable in alfalfa seedings. A good seeding mixture for fields, especially in western Ohio, which are partly acid and partly alkaline, is one of 8 pounds of alfalfa, 4 of alsike and 4 of timothy per acre. Red clover may be added and the proportions varied in accordance with the quality of the soil. This mixture as a substitute for red clover, allowed to stand one year and cut when the alfalfa is read, will often far outyield red clover and produce hay of equal or greater value.

Alsike should always be included in pasture mixtures because of its wide adaptability and persistence under pasturing. It is said, however, that it will produce sores on white skinned horses. This does not usually appear to be serious, and may be avoided by not pasturing it while wet.

SPRING WHEAT IN OHIO

C. E. DIKE

Conditions sometimes arise when it becomes necessary to seek a substitute for one of our major farm crops. In the fall of 1925, farmers in many sections of Ohio were unable to seed the desired acreage of winter wheat, and much of the land intended for that crop has therefore remained idle during the winter months. It seems desirable to substitute something for winter wheat which will not interfere with the regular rotation of crops. It is also desirable that this crop be one that can be converted into ready cash to increase the farm income at a time when the usual wheat crop would be placed on the market.

Many questions have been asked concerning the possibilities of spring wheat's filling this gap. A few of the more promising spring wheats have been tested at Wooster and at several of the district and county experiment farms in the hope of finding something that could be used in place of winter wheat in emergencies of this kind. The average yields of the several varieties tested at Wooster over a varying period of years are as follows:

Variety	Years tested	Bu. per acre
Groff	16	15.50
Blue Ribbon	13	16.10
Marquis	8	10.22
Kubanka	6	11.72
Kota	2	12.24

The highest yield at Wooster was 33.20 bushels per acre for the Blue Ribbon variety in the year 1918. In 4 of the 13 years in which this variety has been tested, yields of more than 20 bushels per acre were obtained. Groff yielded more than 20 bushels per acre in 5 of the 16 years in which it has been tried, the highest yield being 27.83 bushels in 1923. The average yield of ten of the standard varieties of winter wheat at Wooster for the 16 years was 34.59 bushels, or more than double the highest average of the spring wheat varieties.

A comparison of spring wheat with winter wheat, barley, and oats, at Wooster and at the district and county experiment farms is given in the following table.

In order to obtain accurate information as to the yielding ability of any crop it is necessary to raise this crop for several successive years. One wishes to know what the crop will do in an

average season. Enough years must be covered by the test to insure including seasons showing the normal variations in rainfall and temperature. It may be unwise, therefore, to attempt to draw conclusions from the few years' record of yields of spring wheat at some of the farms. It may be noted, however, that the higher yields are recorded in the northern part of the State. The highest single yield, 45.42 bushels per acre, was obtained at the Northeastern Test Farm, Cuyahoga County, in 1918. This unusually successful year was followed by a yield of 6 bushels per acre in 1919, which shows the wide variation in the performance of this crop in Ohio. It may also be noted that the quality of grain secured in years of low yields is frequently poor.

Average yields of small grains in bushels per acre*

County	Number years grown	Spring wheat, Blue Ribbon	Winter wheat, Trumbull	Oats, average 5 varieties	Barley Oderbrucker
Wayne (Station)	13	16.10	34.57	65.84	31.23
Cuyahoga (district farm)	6	20.49	29.46	74.20	....
Hancock (district farm)	5	14.47	20.66	50.51	28.22
Mahoning	8	14.45	30.88	55.19	24.75
Madison	6	13.89	22.92	46.97	22.67
Trumbull	7	13.40	30.22	53.03	23.76
Paulding	5	12.28	26.27	50.41	25.58
Belmont	7	11.91	25.19	50.70	26.74
Miami	4	11.46	29.42	56.63	32.39
Hamilton	7	10.07	29.49	60.62	20.24
Meigs (district)	4	7.16	27.32	33.61	21.30

*Oats 32 pounds, Wheat 60 pounds, and Barley 48 pounds per bushel.

The farmer takes a risk when he sows any crop. Winter wheat is occasionally a failure. In some years oats do not pay for the cost of production. Variations of 50 to 100 percent between different seasons are not uncommon with the corn crop. Yields of spring wheat are likely to be even more speculative in Ohio. Since, however, a considerable acreage of the unseeded winter wheat ground must be planted to some spring grain in order to seed the clover and continue the rotation, some farmers will undoubtedly sow spring wheat and a few comments upon its culture and use may not be out of place.

A soil in a good state of fertility is desirable for this crop. As for winter wheat, it should be worked into a good firm seed bed, and the seed drilled at the rate of about 7 pecks per acre as early in the spring as possible. Results at Wooster indicate that March 20 to April 10 is about the proper time. If the ground can be properly prepared one can hardly sow too early.

Spring wheat is ready to harvest at about the same time as a medium season oat in this locality, the exact date depending somewhat upon the earliness of the variety and the weather conditions.

Spring wheat of good quality finds a ready sale in Ohio, as millers use a considerable quantity each year in making blended flour for bread making. Unfavorable seasons, however, often produce a crop of low yield and a correspondingly inferior quality, in which case it is usually necessary to sell at a lower price or feed the crop upon the farm, with a considerable loss to the producer.

Ohio grown spring wheat, if plump and of good quality, will prove satisfactory for seed purposes. This Station has no spring wheat for sale. Many seedsmen are handling varieties which should prove satisfactory for this State.

The seeding of red clover, or mixtures of red clover, alsike, and timothy may be successfully made with spring wheat, barley, or oats by scattering the seed just ahead of the drill so that it will be covered lightly by the drill hoes, or by broadcasting after the grain has been drilled, and covering lightly with a harrow or weeder.

EMMER NOT ADAPTED TO OHIO

WEEKLY PRESS BULLETIN

Emmer, or speltz as it is sometimes improperly called, is not likely to prove a profitable spring crop in Ohio. It is a great success in semi-arid regions of the northwest, but in Ohio, where rainfall is more abundant, it holds out little hope for planting where winter wheat has failed, or as a substitute for oats or barley.

At the Ohio Agricultural Experiment Station emmer has been grown for 19 years with an average yield of 1157 pounds of grain per acre, in comparison with oats 2116 pounds, and barley 1692 pounds.

The digestible nutrients of emmer, pound for pound, are a little greater than those of oats but less than barley. The feed value per acre, owing to its lower yields, is about 38 percent less than oats and 32 less than barley.

INTESTINAL WORMS IN CHICKENS

B. H. EDGINGTON

Intestinal parasites cause much loss in poultry husbandry. Treatment for the removal of the worms will reduce the losses; *treatment* plus *sanitation* will prevent them.

Worms cause disturbances in the health of fowls in several ways. When in large number they may block the opening of the bowel, preventing the passage of food and causing much irritation to the lining membrane of the intestine. Some parasites, especially the tape worm, bury their head in the mucous membrane, causing injuries thru which disease germs gain entrance. Worms may produce toxic substances which when absorbed act as poisons to the system.

Fowls of any age may become infested, altho young birds are usually most severely affected.

The symptoms of worm infestations are not distinctive and vary somewhat with the character of the parasite and the number present. In general, an unthrifty appearance with progressive loss in flesh suggests the presence of internal parasites. Diarrhea may be seen and disturbance of locomotion is frequently present.

Round worms and tape worms, of which there are several species, are the more common intestinal invaders. The common round worm is from 1 to 2½ inches in length, whitish in color, and threadlike in form. Tape worms vary greatly in size, some being invisible to the naked eye while others may reach a length of several inches. They are white in color and flat or ribbon-like in form. The worm is composed of a head to which is attached a varying number of short sections placed end to end. The heads have minute hooks or may have "sucker disks" by which they attach themselves to the bowel. The attachment at times is quite firm and makes the removal of this type of worm difficult.

TRANSMISSION

The life cycle of but few tape worms in fowls has been definitely determined. However, these so closely conform to the known cycle of similar parasites in other animals as to leave no doubt regarding the general requirements for their propagation.

Tape worm eggs, or ova, are present in the droppings of infested fowls. These ova may be taken up by snails, earth worms,

or house flies and other insects, in the body of which the parasite begins to develop. These infective hosts are in turn taken up by fowls and the life cycle of the parasite thus completed. Since this stage of their development can only occur in these intermediate hosts it is apparent that direct transmission of the parasite from one fowl to another is impossible.

The life cycle of the round worm is probably less complex, a secondary or intermediate host not being necessary for the completion of the life cycle of this parasite. The worm ova are discharged with the droppings of the infested fowl and the life cycle is completed when they are taken up, usually thru contaminated feed or water, by fowls.

Certain heat and moisture conditions are required for the artificial incubation of round worm eggs; this indicates that similar requirements are necessary for their natural development. The length of time these ova may remain viable outside the animal body is not known. Observations indicate that they may remain infective for several months.

Winter months are especially suitable for the eradication of these parasites, since the temperature is seldom favorable for incubation of the round worm eggs and the secondary hosts of tape worms are less available. The fewer number of fowls on hand at such seasons and their confinement to restricted quarters, permit the disposal of their droppings with a minimum amount of labor. Even tho the infested fowls may continue to discharge parasitic ova with their droppings, the probability of re-infestation is much less during the winter than summer months.

PREVENTION

The removal of intestinal worms from fowls by treatment is of limited value unless re-infestation is prevented.

The buildings should be cleaned and disinfected frequently and, when possible, the runways and enclosures rotated, to insure uncontaminated range for the fowls. Since parasitic ova may live for several months outside the animal body and their destruction in soil is uncertain, the rotation of range becomes a prime factor in the ultimate control of these parasites.

All objects coming in contact with droppings of infested fowls are possible agencies in the spreading of parasites. After all loose boards and litter have been removed and all adherent droppings scraped from the floor and droppings boards, the house should be swept thoroly. This cleaning can be made easier if the roosts, droppings boards, and floor are soaked with a hot lye solution. For

this purpose 1 pound of concentrated lye to 30 or 40 gallons of boiling water may be used. The building should then be thoroly sprayed with some reliable antiseptic. Three to five percent compound cresol solution in water is satisfactory.

Keeping fowls off droppings boards and the frequent removal of the droppings are most important requirements. Their access to droppings boards can be easily prevented by the use of wire netting placed beneath the roosts. The droppings should be put into containers that will not permit the entrance of insects or ground worms, or they may be scattered over ground not frequented by the fowls.

The outside pens and runs should be cultivated and the fowls given new range. Where rotation of lots or use of new range is impossible, heavy liming with quick lime has been recommended. Feeding and drinking vessels should be frequently cleaned and disinfected.

TREATMENT

Treatment for the removal of intestinal worms varies both as to materials and methods used. Whether to use individual or flock treatment often depends upon the number and value of the birds as well as the nature of the drug to be administered. Higher efficiency is attained with individual treatment while practical expediency frequently demands administration to the flock as a unit.

The tobacco-mash mixture, recommended by the California Experiment Station, is usually employed for flock treatment in round worm invasion. The mixture consists of 2 pounds ground or powdered tobacco, 1 to 1.5 percent nicotine, thoroly mixed with 100 pounds of dry mash. When exposed to air and moisture for any considerable length of time tobacco loses some of its active principle. For this reason the amount of tobacco-mash mixture made up at any one time should not exceed that which will be consumed by the flock in a few days. This mixture is kept before the birds continuously for 3 to 4 weeks and the treatment repeated, if necessary, after a lapse of 2 to 3 weeks.

At the termination of the tobacco-mash feeding a dose of Epsom salts should be given. One pound, dissolved in a small amount of hot water and mixed with the mash or given in the drinking water, is sufficient for 100 mature fowls, the dosage depending somewhat upon the size of the birds. When the latter metho[illegible] is used no other drink should be available. With flock or mass trea[illegible]

ment it is essential that each bird consume its share of the medicated mash. This does not always occur as frequently the more heavily infested fowls will have a diminished appetite.

The tobacco-mash treatment is not quite so effective in the removal of tape worms, and no entirely satisfactory mass treatment for their elimination has as yet been developed. The lye treatment, recommended by the Oklahoma Experiment Station, is probably the most generally used. To 1 gallon of whole grain add 1 tablespoonful of concentrated lye and cook slowly for 2 hours. A gallon of the mixture when cool is enough for 15 birds.

The fowls should be fasted for 12 to 18 hours prior to feeding the lye mixture. Plenty of drinking water must be given and the birds allowed to consume as much of the mixture as desired. The treatment is followed by a dose of Epsom salts as above recommended.

For the treatment of individual birds turpentine, which is most frequently used, has the advantage of being effective against both the round and tape worm. Turpentine in ½ to 1 teaspoonful dose combined with an equal amount of olive or mineral oil is introduced directly into the crop of the bird. This can be readily accomplished with the aid of a small rubber or glass tube, about 3/16 inch in diameter and 6 to 8 inches in length, to one end of which is attached a small rubber bulb. The dose of turpentine and oil is taken up in the bulb, the bird's mouth opened and the tube passed down the gullet until the end enters the crop. The bulb is then gently emptied. Sudden pressure should not be exerted upon the bulb as its contents may flow back into the bird's mouth and enter the wind pipe. The birds should be fasted for 12 to 18 hours before administering the turpentine. A dose of Epsom salts should be given 3 to 4 hours after this treatment.

The treatment should be repeated in 2 to 4 weeks. A longer interval is not advisable since immature worms that may not have been removed by the former treatment will reach maturity and begin egg deposition.

It is beneficial during treatment to confine the birds to small enclosures thus limiting the dissemination of the parasitic ova and permitting a more ready and thoro removal of all droppings.

Treatment may be summarized as follows:

SUMMARY

Treatment consists in:

A fast and physic to empty the intestinal tract.

Administration of the vermifuge.

Physic to remove worms.

Re-treatment in 2 to 4 weeks.

Treatment alone may remove the worms but it does not protect the fowls against re-invasion.

Prevention is as necessary as treatment.

Frequent removal and proper disposal of droppings are essential preventive measures.

New range or rotation of lots and run-ways is an important factor in parasite control.

Sanitation that prevents worms helps to prevent disease.

BACILLARY WHITE DIARRHEA OF CHICKS

WEEKLY PRESS BULLETIN

Bacillary white diarrhea, an infectious disease which often causes great losses in baby chicks, is usually transmitted thru eggs used for hatching from infected hens.

Some chicks may recover from the disease and carry the infection during their entire life. Hens from such a source frequently have infected ovaries and produce eggs some of which contain the disease germs. These hens appear normal, altho diminished egg production and low hatchability accompany the disease. One infected chick can spread the disease thru an entire hatch. The incubator and brooder will also transmit the disease to later hatches unless thoroly cleaned and disinfected. Affected chicks appear droopy. Diarrhea may or may not be present; when seen it is of a whitish frothly character, adhering to the down about the vent.

There is no established cure for the disease. Healthy chicks should be put in uncontaminated quarters which are cleaned daily. Drinking and feeding vessels should be sterilized preferably by boiling. Good sanitation will restrict the spread of the disease. All sick chicks should be destroyed and dead chicks burned or buried.

Prevention consists in selecting eggs for hatching from flocks known to be free from the disease and avoiding those from hens which have survived the infected hatches or from flocks having a high mortality in their hatches. Infection in a flock can be detected by the agglutination or "blood test".

POTATO LEAFROLL IN OHIO

PAUL E. TILFORD

Leafroll has been reported from every potato producing country of note as one of the diseases causing the "running out" or degeneration of potatoes. Its distribution is general thruout the United States, altho more severe in some sections than in others. For example, it is more prevalent in Ohio than in some of the more northern potato producing states. The writer has observed this disease in potato fields in practically every section of Ohio.

Symptoms on tops.—The name "leafroll" is partly descriptive of the disease. The leaflets of an infected plant roll up along the margins, leaving the midrib at the bottom of a trough. On plants from diseased seed pieces this rolling starts in the lower leaflets and progresses upward thruout the entire plant. Individual leaves have a tendency to be more erect, giving diseased plants a more upright appearance than healthy ones. The leaves of some varieties, like the Rurals, when affected with leafroll tend to become more upright than those of others, like the Irish Cobbler.

Fig. 1.—Leafroll plant on left. Healthy plant on right. Irish Cobbler variety

Another marked symptom is the rigidity or stiffness of the rolled leaflets. They are thick and leathery and may break with a snapping noise when folded or bent. They also have a characteristic rattle when brushed with the hand. Plants from diseased seed are dwarfed, due to having short internodes. The dwarfing,

uprightness, and rolling give diseased plants a very characteristic appearance. The lower, rolled leaflets often show yellowish to reddish discolored areas, which may die later.

Tuber symptoms.—Tubers produced by plants affected with leafroll do not show any definite symptoms whereby they can be detected. They are, however, fewer in number and much smaller than those produced by healthy plants. A characteristic symptom, to be observed when the plants are dug with the tubers attached, is the shortness of the tuber-bearing stolons. Often the tubers appear to be attached directly to the underground portion of the stem, no stolon being present at all. This is well illustrated in Figure 2. Tubers from leafroll plants after being kept in storage during the winter sometimes have a net work of brown strands running thru the flesh. Since this condition, which is called net necrosis, may be caused by one of several factors, it cannot therefore be relied on as a positive symptom of leafroll.

Fig. 2.—Close set tubers on Leafroll plants

It must be made clear that none of these symptoms occur unless the plants are from diseased seed or were infected with leafroll when very young. Plants which become infected after the very first of the growing season will not take on the characteristics of a leafroll plant. They appear practically normal and may not show any symptoms until the next generation of plants is grown from the tubers. It is impossible to distinguish the slight rolling of leaflets, if any occur, from the condition caused by hot, dry weather.

It might be well to mention some other conditions which may mislead the grower in diagnosing the disease. A soil that is too wet will cause healthy plants to take on the appearance of leafroll.

This condition, however, will be confined to low, wet areas in the field and will be general in all the plants thruout such areas. Hot, dry weather will also cause the leaflets of healthy plants to ruffle and roll somewhat. Plants affected by this condition will be limp and not stiff and rigid as in true leafroll. Certain other diseases, such as Rhizoctonia and blackleg, may cause a rolling of the leaves. These diseases have other diagnostic symptoms which distinguish them.

Cause.—No bacterial or fungous parasite has been found to be the cause of the potato degeneration diseases to which leafroll belongs. The disease is extremely infectious, and the infective agent is termed a filterable virus. Juice from any part of a diseased plant contains the virus.

Transmission.—Potato tubers from leafroll plants will produce leafroll plants, even tho the original plants became infected late in the season and showed no signs of disease. Leafroll overwinters in and is transmitted thru the seed tuber.

In the field during the growing season leafroll is transmitted from diseased to healthy plants by the aphid, or plant louse, so commonly found in Ohio potato fields. An experiment was conducted at the Ohio Station in 1924 to prove this point. Healthy seed of the Rural Russet and Irish Cobbler varieties, and seed of the same varieties infected with leafroll were planted in a large aphid-proof cage. The diseased seed produced typical leafroll plants. During August aphids were brought into the cage and released. They multiplied rapidly and moved from plant to plant feeding on both diseased and healthy plants. No indications of leafroll developed on any of the plants from healthy seed during the growing season. These hills were dug separately in the fall and the tubers from each placed in an individual bag in storage. During February, 1925, plants were grown in the greenhouse from tubers produced by the plants which were healthy at the beginning of the experiment. The results follow:

Irish Cobbler	8 healthy plants at start, 5, or 62.5%, became infected
Rural Russet	15 healthy plants at start, 7, or 46.7%, became infected

These results, checked by the fact that healthy plants grown with diseased plants remain healthy in the absence of aphids, prove that aphids transmit leafroll.

Loss due to leafroll.—The loss caused by leafroll is due to the reduced number of tubers per hill and to their smaller size. A greater loss occurs than the actual loss in pounds indicates since

many of the tubers are of an unmarketable size. Tubers from hills infected with leafroll are usually of good quality for table use. Diseased and healthy plants were grown in an experiment in 1925 under comparable conditions to secure information on the effect of leafroll upon yield, with the following results:

TABLE 1.—Average yield of healthy plants vs. leafroll plants per hill

Variety	Weight of tubers per hill		Decrease in weight	Tubers per hill		Decrease in number
	Healthy	Leafroll		Healthy	Leafroll	
	Oz.	*Oz.*	*Pct.*	*No.*	*No.*	*Pct.*
Irish Cobbler......	19.7	6.7	65.9	9.7	5.2	46.6
Rural Russet......	15.8	9.2	41.9	5.4	4.3	20.7

When leafroll hills yield 40 to 65 percent less than healthy hills, and many plants are affected, the loss is bound to be great. (The writer has seen potato fields in Ohio where more than 50 percent of the plants were affected with leafroll.)

Control.—The matter of leafroll control is not a simple one. The disease can not be detected in the seed. No form of seed treatment is effective. Likewise, no sprays are beneficial, except in so far as they control aphids in the field and thus prevent the spread of the leafroll virus. The solution is to plant leafroll-free seed. The difficult part of control then is the securing of disease-free seed. The grower must choose between buying the best seed available or raising his own seed. If the former, where is the seed to be bought?

Some potato growing states, particularly the more northern ones, have sepcialized in the production of certified seed. Certified seed is saved from fields in which the amount of disease has been reduced to a minimum. This is done by roguing out the diseased plants and taking every possible precaution to bring the field up to standards set by officials or by the college of agriculture in that particular state. It must be borne in mind that all certified seed is not equally good. In many tests, however, certified seed has proved far superior to ordinary, unselected home-grown seed.

Some Ohio potato growers may wish to grow their own seed. This is possible, but difficult, because of climatic conditions complicating the detection of leafroll and other diseases. When a growing potato plant becomes infected with leafroll it shows no evidence of disease for at least 30 days, and may not, as brought out above, show disease until the second generation of plants are grown. If current season symptoms do appear they usually show as slight

rolling of the top leaflets. No dwarfing of the plant occurs, unless the infection took place when the plant was very young. This slight evidence of disease can not be distinguished from the rolling and ruffling caused by hot, dry weather. It is a common occurrence in Ohio potato fields during July and August for the leaflets of all plants to show ruffling and more or less rolling. Under such conditions only leafroll plants from diseased seed pieces can be detected and rogued out. Current season infections, when no dwarfing occurs, can not be picked out. Similar conditions prevail in Indiana and most parts of Pennsylvania. In the more northern potato states climatic factors do not prohibit the detection of mild cases of leafroll. More efficient roguing can be done.

That Ohio-grown seed is more difficult to keep free of leafroll than seed grown farther north is proved by disease counts. In 1925 counts were made on plots grown from 16 different lots of the best potato seed produced in Ohio in 1924, and these results compared with disease counts made on plots grown from northern seed. Both lots of seed were comparable in that they had been rogued and especially cared for to produce good seed. The results are given in Table 2:

TABLE 2.—Leafroll in Ohio-grown vs. Northern-grown seed, Series A and B

Source of seed	Plants in plots		Plants with leafroll			
	A	B	A	B	A	B
	No.	*No.*	*No.*	*No.*	*Pct.*	*Pct.*
Ohio	686	601	54	44	7.9	7.3
Northern Michigan	420	369	0	0	0	0

The results clearly show that it is more difficult to produce leafroll-free seed in Ohio than farther north. This does not mean, however, that no good seed is produced in Ohio. Some of the plots from Ohio-grown seed were free of leafroll as well as other degenerative diseases.

SEED POTATOES FOR NORTHERN OHIO

JOHN BUSHNELL

The general shortage and high price of potatoes are stimulating more than usual interest in the question of which are the best seed potatoes for Ohio. During the past few years there has been an increasing amount of certified seed planted. But less certified seed was produced in 1925 than in the preceding year, so a shortage of certified stock may develop this spring with consequent higher prices.

The bulk of the certified seed planted in Ohio is shipped in from northern states. In general, potatoes grown in Ohio are seriously infected with tuber-borne diseases and are not satisfactory for seed. However, a limited amount of certified seed is produced in the northern part of the State. Again, a considerable amount of uncertified seed grown from certified seed has been planted. This seed, one year from certified, has generally been more diseased than new certified stock; but on the other hand has been far superior to seed from uncertified stock.

CERTIFIED SEED FROM NORTHERN STATES

In general northern certified stock has been excellent seed. Thirty-five samples of northern-grown certified Rurals were tested at the Experiment Station during the last four years, and in no case were the plants seriously diseased. The yield records for the first three years were published in the Monthly Bulletin, Jan.-Feb., 1925; those for last year are given in Table 1.

In 1925 these experiments were carried out at the Northeastern Test Farm. The samples were planted late in June. During October, when the tubers should have been making their greatest growth, the soil was too wet, which probably accounts for the low yields. The entire planting was made in duplicate with checks every third row. The yields as given in the table are averages of the two rows planted to each sample, after correcting for soil variations as shown by the check rows.

As in previous years the Russet Rurals from Michigan yielded slightly better than samples from other northern sources.

The variation in yield of the different samples of Michigan Russets was in part related to differences in time of maturity; the rows that were green at the time of digging, October 23, yielded

more than those that had matured. The early maturity was not due to disease, for careful examination revealed only the small percentage of disease noted in the table.

TABLE 1.—Comparison of Northern Grown Certified Seed Potatoes, 1925

Sample	Russet Rural		Sample	White Rural	
	Bushels per acre	Percent disease		Bushels per acre	Percent disease
Michigan			Michigan	152	0
1	177	0	New York	154	1
2	210	1	Wisconsin		
3	141	0	1	140	1
4	157	0	2	144	1
5	133	0	3	150	0
6	156	0			
7	174	0			
8	172	0			
9	167	0			
Av. Michigan	165	0.1	Av. Wisconsin	145	0.7
New York	150	0			

Differences of this type, not due to disease, are attracting increasing interest. Producers and purchasers of certified seed are observing the effect of soil and climate on the value of seed and on the relative merits of the different strains. The causes for the differences in maturity and yield, as found in these tests, have not been determined.

OHIO CERTIFIED SEED

A few growers in northern Ohio have been able to produce consistently good seed for a number of years by late planting and persistent roguing. Some have practiced hill selection and in so doing have secured strains that are more vigorous growing and later maturing than the types grown in the northern states. Other growers have planted seed direct from the northern states and thus produced the early-maturing type that is standard in the north. This has led to considerable confusion, particularly in comparisons of Ohio with northern certified seed.

A number of the growers who passed the certification requirements in 1925 have a strain of White Rural called Sir Walter Raleigh, which has been grown for more than 18 years by Mr. Dan Egbert in the vicinity of Tiffin. In the Station's tests this strain has been later maturing, more vigorous growing, and has produced

Note: Any communication in regard to certification standards or available stocks of seed should be addressed to Secretary, Ohio Certified Seed Potato Growers' Association, Ohio State University, Columbus.

larger, more irregular tubers than the northern type of White Rural. Some other growers have a similar strain of Russet Rural.

The ultimate value of the vigorous growing types is still an unsettled question. They may be planted earlier for the late crop than the earlier maturing sorts. In 1924 they withstood the severe conditions following a heavy rain in July better than the earlier types. It is possible that they may have greater value than the earlier types for certain localities.

The late-maturing types (left) grown for seed in Ohio have much larger tops than the standard Rurals (right)

The various types produced in Ohio have all yielded well in the comparative tests with northern grown certified seed, as shown in Table 2. The averages of the Michigan Russet Rurals are included for comparison with the three types of Rurals certified in Ohio.

Altho the Ohio certified seed yielded well there was a higher percentage of disease in the samples tested than in similar samples from northern states. The diseases in 1925 in the Ohio samples were all of the degeneration type, mostly leafroll.

UNCERTIFIED SEED GROWN FROM CERTIFIED SEED

Ordinary potatoes grown from table stock in Ohio are generally too seriously diseased to be satisfactory for planting. However, faced with the prospective shortage of certified seed, many growers will plant uncertified potatoes. This practice is speculative. Even

TABLE 2.—Ohio vs. Michigan certified seed potatoes

Produced in	Type	Yield in bushels per acre in			
		1922	1923	1924	1925
Michigan	Russet Rural	172	267	179	165
Ohio	Late maturing Whites	....	306	221	158
Ohio	Late maturing Russets	188	228	229	165
Ohio	Michigan type Russets	....	....	188	167

when the tubers are from fields that appeared to be free from disease, there is always the danger that a few inconspicuous plants may have been centers for widespread infection. During some seasons diseases spread rapidly and in others their spread is negligible. The speculative nature of planting tubers grown from certified seed, or, as many growers say, "one year from certified," is shown in Table 3, which summarizes the yields from tubers saved from apparently healthy hills from high yielding strains of certified seed. That is, they were hill selected but not rogued. The uncertified seed was actually superior to the certified two years out of three. This was due to three facts: 1, diseases evidently did not spread the preceding years; 2, the crop was late planted; 3, the conditions of storage were excellent at the experiment station. In the other season, 1924, the yields were seriously reduced by disease. More than one-third of the plants were dwarfed and the yields were correspondingly low. Thus in 1923, in spite of thoro spraying and June planting, degeneration diseases spread to nearly half of the plants, and as a result the tubers from apparently healthy hills were unfit for planting in 1924. The yield was reduced more than 60 bushels per acre by these diseases.

TABLE 3.—Certified seed vs. uncertified stock grown from certified seed

	1923		1924		1925	
	Number of samples	Average bushels per acre	Number of samples	Average bushels per acre	Number of samples	Average bushels per acre
Certified seed	13	254	31	195	29	161
One year from certified	6	286	6	131	4	163
Two years from certified	....	....	4	127	1	161

SUMMARY

Certified seed potatoes have removed a large part of the speculative element in potato growing. In four seasons' tests, certified seed has been consistently satisfactory.

Rural Russets from Michigan were used as the standard for comparison, and on the average outyielded White Rurals from the northern states.

A large proportion of the seed certified in Ohio is of later maturing types than the standard in the northern states. These later-maturing strains in three seasons outyielded and in one season fell slightly below the Russet Rural from Michigan.

Altho in general uncertified potatoes are not satisfactory for seed, in tests with hill selected tubers from a crop grown from certified seed, in two seasons the seed was very satisfactory and in the third it was highly diseased. It is thus speculative to plant uncertified seed even from fields that were grown from certified seed.

These statements are based on four years' tests, conducted at only one place. They are therefore merely tentative generalizations and not to be considered conclusive.

THE SWEET PEA

Planting, Culture, and Varieties

C. W. ELLENWOOD

The sweet pea does best in good rich garden soil, but the preparation is even more important than the kind or quality of soil. The sweet pea is a deep-rooted plant and the soil must permit the roots to penetrate deeply. Shallow preparation of the soil results in a short season of bloom and small vines and flowers. Trenching is the only method of soil preparation that will produce thrifty vines and a long blooming period.

PREPARATION OF TRENCH

The first important step in the successful culture of sweet peas is the preparation of the trench. In order to get as nearly uniform sunlight as possible the trench should extend north and south. Partial shading during the early afternoon in July and August is an advantage. This can be accomplished by the practice of planting near a row of current bushes, shrubbery, or sweet corn.

Better results are usually secured if the trench is prepared in the fall. Freezing and thawing during the winter and early spring greatly assist in fitting the soil. Only under very favorable weather conditions will spring preparation of the trench equal that of fall preparation. In either case the mode of preparation is the same.

For a single trellis excavate a trench 18 inches wide and about 18 inches deep. Throw the dirt out of the trench so that the top soil may be readily accessible when the trench is refilled. If the soil is heavy a layer of coarse cinders in the bottom of the trench will aid in drainage. The next step is to fill in a layer of 5 or 6 inches of well-rotted manure. Then fill the trench to within 2 inches of the top with the good soil. An application of 1 or 2 pounds of acid phosphate or bone meal and 4 or 5 pounds of hydrated lime to each 10 feet of row on top of the soil completes the fall work except that care should be taken to see that surface drainage is sufficient to prevent water standing on the trench for long periods during late winter.

If the trench is not made until spring the manure, lime, and fertilizer should be well mixed with the soil as it is put back into the trench.

The sweet pea is a leguminous plant and will not thrive on an acid soil, such as is found in many gardens, hence the addition of lime may be necessary.

PLANTING

The second important step is to get the seed planted just as early in the spring as the ground can be fitted This is usually as early as the middle of March in southern Ohio and late March or early April in northern Ohio. Varieties having dark-colored seeds may be planted somewhat earlier than those having light-colored seeds. If the trench was prepared the previous fall it will only be necessary to spade the soil to the depth of 4 or 5 inches. The soil should then be fitted as for any garden crop. If the trench is 18 inches wide one row can be planted down the middle or better two rows 8 to 10 inches apart to be trained on a single trellis.

The seed should be planted 2 or 3 inches apart in a furrow about 3 inches deep. Varieties having light-colored seeds should be sown thicker than the dark-colored seeds, especially when planted early, as their germination is not usually as high as the dark-colored seeds.

Some growers get better and quicker germination by soaking the seed in warm water for a day prior to planting.

Certain varieties may be planted in the fall with a fair amount of success. The preparation of the soil is the same as for spring planting. The seed should be planted 3 or 4 weeks before danger of heavy freezing. If the plants appear above ground before freezing occurs they may be given some protection by boards or by covering with sashes. If sashes are used to cover the trench they should be removed early in the spring to prevent injury from burning on bright days. If the seed germinates but does not come thru the ground a mulch of manure over the top of the trench during the winter is sufficient. Before planting sweet peas in the fall it is well to consult your seedsman concerning the varieties best adapted for fall planting in your locality.

CULTIVATION

As soon as the plants are all thru the ground cultivation should begin and the ground be kept cultivated lightly but thoroly thruout the season, a dust mulch helping materially to maintain moisture. When 5 or 6 inches high the plants are thinned to stand about 6 inches apart in the row. If allowed to remain too thick the result will be weak vines and small flowers on short stems. As far as possible moisture should be maintained by either cultivation or a mulch of strawy manure. When necessary the ground should be thoroly soaked. It is better to water thoroly two or three times a week than to sprinkle lightly more often.

TRAINING

There are several methods of supporting the vines. The oldest and the one to which the plant most naturally adapts itself is the brush method. This consists of sticking brush along the row. Prunings from apple trees or any other brush not too dry may be used. Brush from birch trees makes a very satisfactory support.

Wire netting is the trellis most commonly used, a coarse-meshed poultry wire 48 to 60 inches high being used. This presents a neater appearance and is more quickly prepared than brush. The objection to netting is its liability to injure the foliage of the vines by burning on hot days.

A third method and the one preferred by the writer is a combination wire and twine trellis. This trellis is made by supporting three wires on substantial 2 by 2-inch stakes standing 5 or 6 feet out of the ground, and not more than 10 feet apart. The wires are stretched from the top, middle, and near the bottom of the stakes.

Soft wool twine, or other twine of similar weight, is woven rather tight perpendicularly between the wires. Two wires give fairly satisfactory results but three are better.

Sweet peas supported by twine trellis

Regardless of the kind of trellis used, it should be installed soon after the peas are planted and the plants permitted to start their natural vining habit at once. If two rows are planted in a trench, the trellis being in the middle, the vines are trained each way to the trellis.

CUTTING THE FLOWERS

Properly planted, given good cultivation and sufficient support, the chief essential in securing a long blooming period is frequent and thoro cutting of the flowers. It is not sufficient to cut the larger flowers, but all inferior blooms must be removed if the flowering season is to be prolonged. If seed pods are permitted to form the strength of the plant will soon be exhausted.

The best time to cut sweet peas is in the early morning or evening and when the upper flower on the stem is nearly open. Allowing the stems to stand in water a few hours before using enhances the value of the blooms.

As a precautionary measure against some diseases that are not controlled by spraying, it is best not to grow sweet peas on the same site two years in succession but to rotate with some suitable crop.

In Ohio the chief pest of this plant is the green aphis. This insect is much worse during some seasons than others and not only devitalizes and finally kills the plant by sucking the juices, but serves as an agent to carry diseases. Successfully controlling the green aphis ordinarily means success in controlling all pests. This can be accomplished by spraying with a solution of nicotine sulphate diluted 1-800, or 1 to 2 teaspoonfuls per gallon of water, with a small amount of laundry soap added; or by dusting with commercial nicotine dust prepared for garden crops. Probably the dust treatment should be recommended for the small garden. Dusting is done early in the morning and should be started at the first appearance of the aphis.

Red spider sometimes becomes a serious pest. Being minute in size and generally on the under side of the leaves, it may do considerable damage before being recognized. Spraying with clear water is the usual treatment. The lady beetle is a beneficial insect and is one of the best agents in the control of these insects.

SEED GROWING

Some persons save seed from their own vines. However, more satisfactory results will be secured from using seed from the seedsmen specializing in sweet peas. Nearly all the sweet pea seed sold in this country is grown under especially favorable conditions in California. Where more than one variety is grown in a short row seed soon becomes badly mixed.

There are a great number of varieties worthy of a place in the garden. Among good varieties of varying shades of color and rather generally catalogued are King White, Margaret Atlee, Wedgewood, Sunset, Royal Scot, Fiery Cross, King Edward, Renown, Picture, Hawlmark Pink, Tangerine, Pres. Harding, and Orchid Improved.

OLD GLACIAL LIMESTONE SOILS OF OHIO

G. W. CONREY

The area of old glacial limestone soils is confined to parts of seven counties in the southwestern part of the State. Within this region the soil-forming materials have been subject to weathering action for such a long period of time that soils have resulted which have characteristics quite distinct from those of the counties to the north.

Origin of the soils.—The upland soils of the region have been formed largely from the weathering of glacial drift deposited by the ice during one of the early glacial periods. Estimates by geologists place the time since this early glacial period (the Illinoian) at about 300,000 years, as compared with about 30,000 years, the time since the more recent glacial period (the Wisconsin), during which the deposits of western Ohio were formed. The significant fact is that the soils of southwestern Ohio have been subjected to the processes of solution, leaching, etc, for at least 10 times as long as those of the counties to the north, with the result that the more soluble constituents have been very largely lost from the soil, the lime having been removed to a depth of 8 or 10 feet. The residue which forms the soil of today consists of a very thoroly leached silty material which nearly everywhere covers the upland surface of the region.

Area of old glacial limestone soils

It has been suggested that this silty deposit is of loessial, or wind-blown, origin. It is notably free from coarse gravel or bowlders; but a careful examination will reveal the presence of small rounded fragments of quartz, quartzite, and chert on the surface and thruout the soil and subsoil. The presence of this fine gravel is difficult to account for on the basis that the silts are wind-blown deposits. More recently it has been suggested that these

deposits are in reality a very thoroly weathered and leached glacial deposit from which all coarse material has disappeared except the more insoluble portion such as quartz and chert. The latter explanation seems to be very plausible.

The underlying rocks of the region are limestone and shale. On the slopes adjacent to the Ohio River shale predominates, whereas on the uplands in the northern part of the region limestone makes up over 75 percent of the bed rock.

On steep slopes, where erosion is active, all evidence of glacial deposits has been removed, and the soils are essentially residual in origin.

Topography and drainage.—This region presents great contrasts in topography. The upland is a plain about 450 feet above the Ohio River and, on the broad divides, presents a surface as level as any area in the State. Such tracts are naturally very poorly drained.

A number of large streams, occupying valleys with steep valley walls, cross the region. Tributary valleys lead from several miles back, giving to these portions of the area a topography that is rolling to steep and broken. On such lands erosion is a serious problem.

SOILS OF THE OLD GLACIAL LIMESTONE REGION

A. Old Glacial Soils

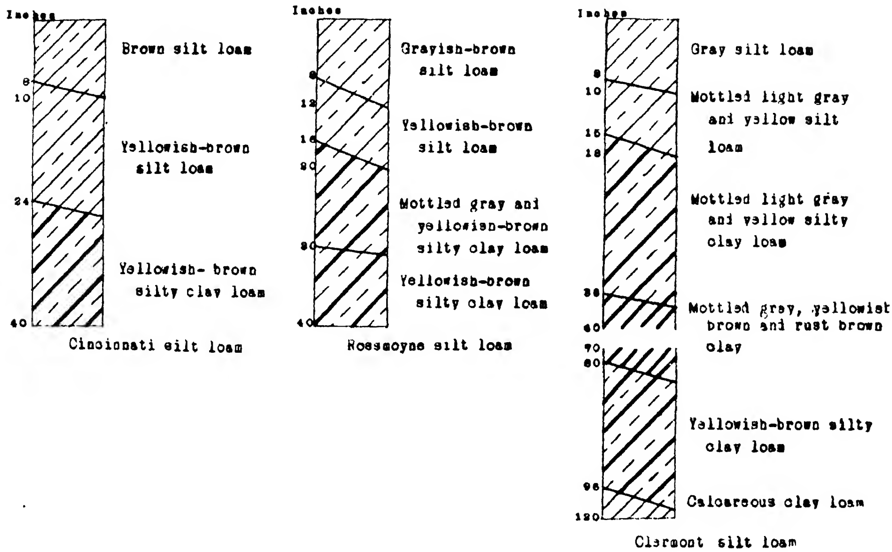
Differences in topography and drainage, have resulted in soils of markedly different characteristics. The upland glacial soils have been included in four different series: Cincinnati, Rossmoyne, Clermont, and Cory. The Edenton is a transitional soil, intermediate between glacial and residual.

Cincinnati series has brown surface soils and yellowish brown subsoils. Mottling is uncommon within 30 or 36 inches of the surface. Limestone bed rock usually occurs at 4 to 6 feet. These soils occupy narrow ridge tops and rolling uplands and are naturally well drained. The most extensive areas are in Hamilton County, and elsewhere in the rolling uplands adjacent to the main valleys of the region. The soil contains little gravel or angular fragments and hence erodes very easily. It generally shows an acid reaction. These soils are used chiefly for general farming, altho considerable truck is produced in the vicinity of Cincinnati. The rolling uplands furnish admirable sites for numerous orchards. Cincinnati silt loam is the most important type.

OLD GLACIAL LIMESTONE SOILS

	Old glacial limestone soils				Residual soils		Terrace Soils (second bottom)			Flood plain soils (first bottom)
Color of soil	Brown	Grayish-brown	Gray	Dark gray	Brown	Brown	Brown	Brown to dark brown	Grayish-brown	Grayish-brown to brown
Color and	Yellowish-brown	Brownish-yellow	Mottled light gray and yellowish-brown	Mottled gray, bluish-gray, and yellowish-brown	Yellowish-brown	Yellowish-brown to olive-brown	Reddish-brown	Brown	Yellowish-brown slightly mottled	Light brown
Character of subsoil		Mottled gray and yellowish gray below 16 to 20 inches			Plastic clay below 30 to 40 inches	Very heavy Bedrock (Limestone and shale) at 24 to 36 inches	Stratified sand and gravel at 2 to 5 feet Limestone material	Stratified sand and gravel at 5 to 8 feet Mixed material Sandstone, shale, and limestone (Ohio River)	Stratified silt and clay at at 3 to 4 feet	
Topography	Rolling	Undulating to gently rolling	Level	Level	Sloping	Steep slopes	Level	Level	Level	Level
Natural drainage	Good	Fair	Very poor	Very poor	Good	Good	Good	Good	Fair	Fair to good
Series	**Cincinnati**	**Rossmoyne**	**Clermont**	**Cory**	**Edenton**	**Fairmount**	**Fox**	**Wheeling**	**Williamsburg**	**Genesee**
Important textures	Silt loam	Silt loam	Silt loam	Silt loam	Silt loam	Silty clay loam	Fine sandy loam loam silt loam	Loam silt loam	Loam silt loam	Loam silt loam

The Rossmoyne series is characterized by grayish-brown to brown surface soils and yellowish-brown upper subsoils. Below 16 to 20 inches the subsoil is mottled gray and yellowish brown. The soil occupies broad upland divides with an undulating to gently rolling topography. The surface drainage is good, but the underdrainage would be improved by tiling. These soils are slightly acid at the surface, and more strongly so at 18 to 24 inches. The underlying calcareous glacial drift occurs at 8 to 10 feet, the soil having been leached of its carbonates to this depth. The silt loam is the chief type. This type and the Clermont silt loam occur on the Clermont County Experiment Farm.

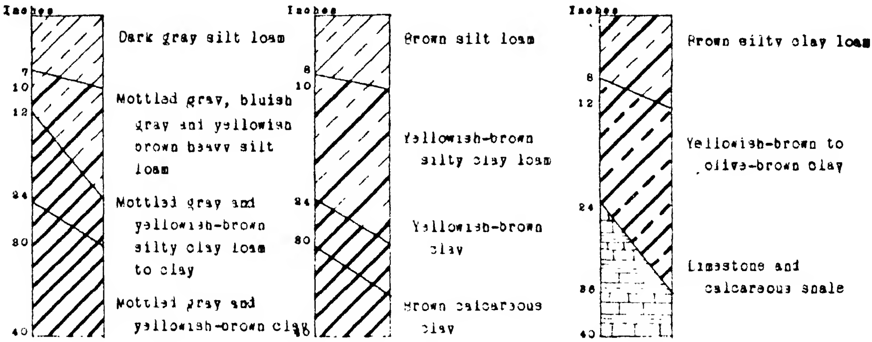


Clermont series.—The surface soil of the Clermont series is gray in color to a depth of about 8 inches. The subsoil is mottled light gray, yellowish brown, and rust brown. At a depth varying from about 16 to 24 inches the subsoil becomes very heavy and impervious, and is usually spoken of locally as "hardpan". Below 36 inches the rust-brown iron stains increase in amount giving the subsoil a dark color. At 6 to 8 feet the dark layer gives way to a yellowish-brown color, and at 8 to 10 feet a calcareous clay loam occurs. Both the surface soil and subsoil are very acid, the acidity increasing with depth to 2 or 3 feet. Coarse gravel or angular fragments are rare; but fine gravel, consisting of quartz, quartzite, and other resistant minerals, exists in the surface and subsoil.

The Clermont is one of the most extensive and characteristic soils of the region. It is known locally as "white clay". It occupies

the broad level upland divides where the surface is flat to very gently undulating, and the natural drainage is very poor. Thoro tiling is difficult and expensive. Shallow surface ditches are resorted to as a means for the removal of the surface water.

In common with the other upland soils of the region, the Clermont is very thoroly leached, so that it is not only difficient in lime, but also in phosphorus, and potassium, and in general is of rather low natural fertility. Adequate drainage, fertilization, and liming are essential for the improvement of this soil. Clermont silt loam is the important type. This is one of the soils on the Clermont County Experiment Farm.



Cory silt loam — Edenton silt loam — Fairmount silty clay loam

Cory series.—The surface is dark gray and the subsoil mottled gray, bluish gray, and yellowish brown. It is known locally as "dark land", "black land", or "maple swamp". Altho the content of organic matter is not high, it is enough greater than that of the Clermont soil to make the Cory the more fertile of the two. It occupies level to slightly depressed areas in association with the Clermont soil. The natural drainage is very poor, but in general it is more easily drained than the Clermont. It is very acid. Cory silt loam is the important type.

Edenton series.—This series is intermediate in character between the Cincinnati and the Fairmount soils. The upper 30 to 40 inches is similar to the Cincinnati soil, consisting of a brown surface soil and a yellowish-brown subsoil. The lower subsoil consists of a yellowish-brown to olive-brown plastic clay, which is essentially residual from limestone and shale, as is the Fairmount series. The Edenton soils occupy sloping areas in minor valleys, especially the upstream part of the valleys. In places the subsoil at 30 to 40 inches is a calcareous glacial material. There is sufficient lime in the soil to make it naturally better adapted to legumes and blue

grass than the Cincinnati series. A considerable portion of the land is still in timber. If cleared it is utilized largely for permanent pasture. Edenton silt loam is the principal type.

B. Residual Soils

Fairmount series.—The surface soils are brown and the subsoils yellowish brown to olive brown. The texture, especially of the subsoil, is a silty clay loam or silty clay. Bedrock—limestone and shale—occurs at 24 to 36 inches. This soil, being residual from limestone and calcareous shale, is seldom acid.

The Fairmount soils occupy very steep slopes along the major valleys of the region. The drainage is good. Altho too steep for intertilled crops, under ordinary conditions, a considerable area of these soils is used for tobacco and corn, it being possible to grow one crop without serious erosion. Following the cultivated crop the land is commonly seeded down. Alfalfa and sweet clover do extremely well, and the acreage is increasing. Excellent burley tobacco can be raised on these limestone soils. Careful attention to the prevention of erosion, which means keeping the land seeded down a large part of the time, is of first importance. A considerable portion of the series is probably best suited for forestry. Fairmount silty clay loam is the important type.

C. Terrace Soils

Associated with the old glacial limestone soils which occur on the upland are the terrace or second bottom soils which exist in the numerous valleys of the region. These have been included in the Fox, Wheeling, and Williamsburg series.

Fox series.—The surface soil of the Fox series is brown and the subsoil reddish brown. The substratum at 2 or 3 feet is stratified sand and gravel, predominantly limestone material. These soils occur as terraces or second bottoms along streams or valleys which enter the region from the glacial limestone region to the north. These terraces are continuous with those to the north and are probably of the same age. Their chief development is along the valleys of the Little Miami, Great Miami, and Whitewater Rivers and Mill Creek. The topography is level and the drainage good. These soils are seldom acid and usually very fertile. Fox fine sandy loam, loam, and silt loam are important types.

Wheeling series.—The Wheeling soils have brown to dark brown surface soil. This is underlain by a brown subsoil showing

very little change to a depth of 36 inches. Gravel and sand, predominantly sandstone and shale material, exist at 5 to 8 feet. Minute mica flakes are common in both the soil and subsoil. These soils occur as a second bottom or terrace along the Ohio River, and are derived from mixed materials, predominantly sandstone and shale, with minor limestone, from regions up the Ohio valley. The topography is level and the drainage for the most part is good. The soil is slightly acid to neutral and very fertile. Loam and silt loam are the most important types.

Williamsburg series.—The surface soil is grayish brown and the subsoil yellowish brown. Commonly the lower subsoil is mottled yellowish gray and yellowish brown. The substratum consists of silt and clay, probably back water or slack water deposits. The topography is level and the drainage fair. The most important types are Williamsburg loam and silt loam.

D. Flood plain Soils

These soils exist as first bottom lands along the streams of the region and are of alluvial origin, being the wash from the surrounding uplands. They are subject to annual overflow. They have been included in the Genesee series.

Genesee series.—The surface soils of the Genesee series are grayish brown to dark brown and the subsoils are yellowish brown without much change to a depth of 36 inches or more. This series includes the principal first bottom soils of the region. These bottom soils are subject to annual overflow except where protected by dykes. The topography is level and the drainage fair to good. Genesee soils are very fertile. They are utilized chiefly for corn or permanent pasture. The most important types are Genesee loam and silt loam.

SHEEP AND WOOL PRODUCTION IN SOUTH-EASTERN OHIO

E. J. UTZ*

With the present tendency to increase the number of breeding ewes, sheep men are wondering how long the prices of wool and lambs will remain somewhere near their present level. We always find variations in numbers of sheep following pretty closely after the variations in price. However, a large majority of the sheep men keep about the same number of sheep year after year, regardless of price levels, depending upon efficient flock management to make a fair profit on the average. These men are the backbone of the industry in this country.

The sheep men in southeastern Ohio and adjoining territory of other states are largely of this type. This section has produced fine wool for at least a century, and of such good quality that it has become a standard in our eastern wool markets. In 1870 there were nearly five million sheep in Ohio. The number has decreased to about two million at present, with over half of that number in twenty of the hilly counties of the southeastern part of the State.

For each of the past four years some twenty farmers in Morgan and Noble Counties have kept complete cost records on their flocks in cooperation with the Department of Rural Economics of the Ohio State University. Thirteen of these have completed the work for all four years and their records are used in this report.

The men who cooperated in this work were visited each spring and the records kept for the previous year were collected and checked over. Complete records were kept of the amounts of feed consumed, labor expended in the care of the flock, cost of shearing, and miscellaneous items, the number of fleeces clipped and the total weight and grade of the wool when shipped, and of all sales and purchases of sheep and lambs.

The general type of farm of this group is rather characteristic of a large part of the hill section of the State, except that it carries more sheep than the average. The farms of this group average 190 acres, of which 124 acres, or 65 percent, is in pasture, and about 20 acres, or 10 percent, is in woods and waste land. Of the 25 percent which is crop land, 29 acres is in hay, 9 acres in corn, 7 acres in wheat, and 1 acre in oats. At some time or other 78 percent of the total area was under cultivation; but, due to the roughness of the

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land, the steeper slopes have been worked back to pasture and only the more level fields are now cropped. These hillsides make excellent pasture for sheep.

About 40 to 45 percent of the income on these farms was from sheep, making this industry by far the most important source of income. Next in order came beef cattle, returning about 20 percent; poultry 20 percent; dairy cattle 15 percent; and hogs only about 4 percent of the total income. Of the receipts in the sheep industry about 75 percent came from wool and the remainder from the sale of sheep and lambs. From 90 to 95 percent of the wool graded as fine delaine.

In determining the profits per sheep in these studies the flocks were charged with home-grown feed at average price as given by the cooperators; purchased feed, shearing, twine, and miscellaneous items at their cost price; labor at the average estimate of the farmers; depreciation on buildings and equipment at 3 percent; taxes and insurance on buildings, equipment, and flock inventory at 2 percent; and interest on total investment at 5 percent. Any loss in flock value was also considered as an expense. The flocks were credited with increase in value; with sales of sheep, lambs, and wool; and with 50 percent per head for manure during the feeding season. The difference between the gross income and total expenses for the entire flock divided by the average number of sheep for the year was considered as the profit per sheep.

HEAVY FLEECES IMPORTANT

In 1840 the clip in Ohio amounted to only about 2 pounds per fleece. As a result of careful selection and breeding the average for Ohio had increased to 7.3 pounds in 1924. The flocks under study in Morgan and Noble Counties for the four years of record averaged 9.06 pounds per fleece, showing them to be far above the present state average. However, there was a range in the four-year average fleece weight on the different farms from 7.95 pounds to 12 pounds. Since fleece weight is one of the primary indications of quality, the flocks were grouped according to weight per fleece. The five flocks having highest average weight of fleece were compared with the five having lowest average.

Table 1 shows feed cost along with profit and weight per fleece. This indicates that care as well as quality has its influences on the wool clip. The greater cost of the feed of the high producing flocks was due to its better quality rather than to larger quantity. The

other charges of insurance, taxes, and interest were correspondingly higher in the case of the light shearing flocks. Their inventory value of the heavy shearing flocks was about 30 percent higher than the low shearing flocks, and about 11 percent higher than the average of all flocks. Thus we find that quality of sheep as reflected in fleece weight is an important factor in the profits of the sheep business.

TABLE 1.—Relation of Weight of Fleece to Profit and Feed Cost

	Weight per fleece	Feed cost per sheep	Profit per sheep
	Lb.	*Dol.*	*Dol.*
Average 5 flocks with high weight per fleece	10.24	3.32	2.88
Average 5 flocks with low weight per fleece	8.25	2.63	1.14
Average of all 13 flocks	9.06	2.97	1.66

LAMBS NECESSARY TO GOOD PROFITS

A second factor, not having so much to do with the quality as with the kind of sheep kept and the management of the flock, is the percentage of lambs raised. At one time the common practice in this section was to keep practically all the lambs, wethers as well as ewes, until they were five or six years of age before selling them. Frequently only a very small percentage of the total flock was made up of brood ewes. This practice is still followed to a greater or less extent by some of the men. Others carry a much larger percentage of brood ewes and count on selling the surplus ewe lambs and the wether lambs at 12 to 15 months of age. They usually clip the lambs before selling, thus securing a lamb and two fleeces per year for each brood ewe in the flock.

The number of lambs raised per 100 sheep in the flock varied from 18 to 42 on the different farms, with an average of 29 lambs per 100 sheep for all flocks. In Table 2 the five flocks having the highest percentage of lambs are compared with the five having the lowest percentage and with the average.

Table 2 shows that the five flocks having the most lambs raised per 100 sheep had 48 percent bred ewes, while the low lamb producing flocks had only 36 percent. The percentage of lambs raised to number of ewes bred was 77, the same in both groups. However, the flocks not among the high or low groups raised enough more lambs per bred ewe to bring the average of all up to 80 percent. Consequently the care of the flocks during lambing would appear to be about equal in the high and low group and the difference in profit would be largely attributed to the higher percentage of lambs

per flock or the higher percentage of brood ewes. The first point of weight of fleece is based on quality and care combined, while percentage of bred ewes is based on management alone.

TABLE 2.—Relation of Lambs Raised to Profits

Averages	5 flocks having highest percent of lambs	5 flocks having lowest percent of lambs	13 flocks
Size of flock	71	127	99
Number of ewes bred	34	42	35
Percent bred ewes	48	33	36
Number of lambs raised	26	27	28
Number lambs raised per 100 sheep	37	21	29
Number lambs raised per 100 bred ewes	77	77	80
Profit per sheep	$2.04	$0.95	$1.66

Table 3 shows that it took a small amount more feed and labor to care for the flocks having a high percentage of lambs. Another point to be considered along with the labor expenses is the fact that the five flocks with a small percentage of lambs, were more than 75 percent larger than the others and should have taken considerably less time per sheep for care. These sheep were valued somewhat higher because of the larger percentage of brood ewes in the flocks. However the increase in expense per sheep amounted to only about 12 percent of the total cost.

TABLE 3.—Distribution of Costs and Credits on Basis of Percentage of Lambs Raised

	5 flocks having highest percent of lambs	5 flocks having lowest percent of lambs	Average of 13 flocks
	Dol.	*Dol.*	*Dol.*
Expense			
Feed cost per sheep	3.19	2.88	2.97
Man and horse cost	.83	.80	.75
Interest, insurance, taxes and use of buildings	.87	.67	.71
Total cost	4.89	4.35	4.43
Credits			
Increase in flock value including sales of sheep and lambs	1.18	0.53	0.83
Value of spring lambs	.81	.41	.56
Value wool produced	4.46	3.90	4.23
Credit for manure	.48	.46	.47
Total credits	6.93	5.30	6.09
Profits per sheep	2.04	0.95	1.65

The big variation between the two groups is found in the credits. The wool clip per sheep was nearly one pound greater in the case of the high flocks, but the increase in flock value and lambs produced was over twice as much with the five high lamb producing

flocks. The total credits were more than 30 percent higher. The policy of having more brood ewes per flock undoubtedly presents one of the biggest chances of increasing the profits in sheep management in this section of Ohio.

Table 1 brought out the fact that the high quality sheep received more and better feed and in spite of that returned considerably more profit. The number of flocks completing all four years was not great enough to make any comparison of the rations fed since none of the men fed the same ration for the whole period. However taking all flocks into consideration, the average pasture season was 204 days in length at a cost of 92 cents per sheep. In the average feeding season of 161 days, 267 pounds of roughage was consumed per sheep at a cost of $1.61. The most of the roughage fed was mixed hay and alfalfa. Some timothy and corn stover were fed with these fed to a few flocks. Only one or two flocks received any silage. The average amount of grain per sheep on feed was 29 pounds at a cost of 41 cents. The greater part of the grain was corn, with some oats and bran. A few flocks received some oilmeal or cottonseed meal at lambing time and in feeding out the lambs. Most of the flocks received but little grain, except just before and during lambing time and again for the lambs that were being conditioned for market. Salt was used at the rate of 3.4 pounds per sheep at a cost of 3 cents for the year.

The following prices were used for feed, labor, and wool in these studies:

	1921–22	1922–23	1923–24	1924–25
Corn per bushel	$ 0.65	$ 0.85	$ 1.00	$ 1.45
Oats per bushel	.50	.60	.60	.65
Mix hay per ton	13.00	12.00	15.00	12 00
Alfalfa per ton	16.00	15.00	18.00	15.00
Man labor per hour	.25	.35	.25	.25
Horse labor per hour	.15	.20	.15	.15
Pasture per month	.15	.15	.15	.15
Silage per ton	5.00	5.00	5.00	....
Fodder per ton	4.00	4.00	4.00	4.00
Wool				
Fine delaine per pound	.53	.53	.50	.50
Fine clothing per pound	.46	.46	.43	.43

Comparisons were made in individual years showing the advantage where alfalfa and clover hay were used as compared to timothy and mixed hay. Results showed a greater profit on the average where legume hays were used. However no one flock was fed the legume hay all four years. This was due to clover failures, competition from other classes of livestock, and various other factors.

The nutritive ratio of the average ration fed on all farms was 1:8.7. However the number of farms was too small to get a comparison on this factor and its influence on profits. The ratios varied from 1:4.5 to 1:11.2.

CONCLUSION

The four-year study on these thirteen flocks in Morgan and Noble Counties has shown the importance of the following points in sheep management.

1—Only flocks of high quality as shown by heavy wool and lamb production should be kept. This quality may be secured by careful selection of breeding stock and culling out of the poor wooled ewes.

2—A large percentage of the flock should be brood ewes.

3—Flocks of sufficient size should be kept to give efficiency in the use of labor and equipment.

4—Enough feed should be fed to give the sheep a chance to produce a good fleece and a lamb.

5—Good legume hay should be fed whenever possible.

THE HOG SITUATION

J. I. FALCONER

The December pig survey conducted by the U. S. Department of Agriculture thru the rural mail carriers has much of interest to the Ohio hog raiser. These surveys were started in 1922 and have proved remarkably accurate indicators of future hog supplies.

The number of fall pigs raised last year shows a reduction of 12.4 percent below the number saved in the fall of 1924. Ohio shows a reduction of 19.2 percent. This reduction was doubtless due to the extremely bad weather during the last fall which contributed as much to reducing the number of pigs saved per litter as good weather did toward increasing the number saved last spring.

The survey also carries the information that there were about 11 percent more brood sows bred this fall for spring farrowing than farrowed last spring. Ohio reported the smallest increase, 3.4 percent, of any corn belt state. These advance farrowing estimates due to the weather hazards and the chance of increasing the number of sows thru late breeding or decreasing the number thru disposal of sows, have never been as dependable as the pig surveys. However, due to the normal 10 percent discount which must be taken from fall breeding to get at spring farrowing, this increase of 11 percent does not appear abnormal; nor is last spring's unusually warm farrowing season likely to be repeated.

The encouraging aspects of the hog situation may be summarized as follows:

1. There are 5 percent fewer lambs on feed in the corn belt than a year ago and 3 percent fewer beef cattle. This is a factor in future meat supplies.

2. An unusually large percentage of the cattle on feed are light stuff purchased for long feeding which would indicate reduced steer supplies during the late winter and early spring.

3. Meat in storage was 14 percent below the 5-year average on November 1; pork 9 percent below normal.

4. There were about 10 percent fewer pigs raised last spring than a year ago. These are the pigs that will come to market this winter.

5. The country is very prosperous, which is holding the consumption of all meats at a high level.

6. If the December pig survey proves as accurate as former surveys, there will be fewer pigs to be marketed next summer than last by 12.4 percent.

7. Tho the pig survey next June will tell the story, advance brood-sow estimates do not indicate an extreme increase in hogs for market for next fall and winter.

Some of the discouraging signs are as follows:

1. Cheap corn may be expected to encourage feeding of both lambs and steers to unusually heavy weights.

2. Hogs coming to market this winter are averaging the heaviest in a number of years.

3. Hog receipts during October were 15 percent less, in November 25 percent less, in December 38 percent less, and during the first three weeks of January 25 percent less than for the same periods a year ago. If the spring survey, indicating 10 percent fewer pigs raised, is as accurate as surveys in past years, there will have to be an increase in the marketings of hogs in proportion to normal during the coming three months.

THE 1925 FARM CENSUS FOR OHIO

J. I. FALCONER

The results of the 1925 farm census, which are now available, show some interesting comparisons between 1920 and 1925.

The census of 1920 showed the value of Ohio farm land and buildings to be $2,661,435,949. In 1925 it was $1,943,150,524. In 1920 the average value of land and buildings was $113 per acre, by 1925 it had fallen to $87, a decrease of 23 percent in five years. Land alone without buildings decreased 35 percent in value. The war-time inflation has all been taken out of farm land values in Ohio.

During the five years the area of land in farms decreased approximately 1,250,000 acres or 5.5 percent. The number of farms in the State decreased from 256,695 to 244,703, a decline of 11,992, or about 5 percent; at the same time the average size of farms decreased from 91.6 acres to 90.8 acres.

While the average farm has decreased in size, there is a wide variation in the different parts of the State. In northwestern Ohio the tendency has been for farms to increase in size. In Paulding

County, for instance, where the average size was 65.6 acres in 1900, and 102 acres in 1920, it was 111 acres in 1925. In Hardin County the average size increased from 95 acres in 1920 to 102 acres in 1925. In northeastern Ohio, on the other hand, farms have decreased in size. This decrease in size has been largely due to the prevalence of a large city population, the development of vegetable growing, and the increase in number of small farms in the vicinity of cities. In Summit County, containing Akron and other cities, the average size has decreased from 80.7 to 74.2 acres. In northwestern Ohio, with fewer cities and with farming more general, the adoption of larger units of machinery has led to a gradual increase in the size of farms. In the general farming area of the State the number of small farms of 50 acres or less is becoming smaller. Madison County, has the largest farms, averaging 158 acres. In southern Ohio there has been little change in size of farms.

Tenancy decreased from 29.5 percent in 1920 to 25.5 percent in 1925. These figures are significant, as ever since 1880, when figures showing the percent of tenancy were first collected, the number of farms operated by tenants had been increasing. The larger part of this decrease in tenancy has taken place in the eastern and lower land value section of the State. Jackson County, with 9.3 percent of its farms operated by tenants, has the lowest percentage of tenants. Madison County, with 50.9 percent tenancy, has the largest and is the only county in the State where over one-half of the farms are operated by tenants.

INCOME AND TAXES ON OHIO FARMS

O. M. JOHNSON

It seems to be fairly well agreed that taxes are paid out of incomes. Two questions arise as to the relation of income and taxes: First, what part of the income of an individual or group of individuals is used for taxes? Second, is the proportion of the income of one group paid in taxes a fair one when compared with some other group? For example, what is the relation between the percentage of a farmer's income used for taxes and that of merchants?

The records obtained by the Rural Economics Department for the period 1914-1924, inclusive, will throw some light on the ques-

tion concerning the proportion of the farmer's income used for taxes. Since 1914 surveys and account books giving income and expenses on farms in different parts of Ohio have been summarized each year.

The percentage of the net income of farmers actually paid in taxes is shown for four periods. As a basis for comparing the incomes of the farms in the different periods the rate obtained on total capital is used. This varies from 3.4 percent to 8.4 percent in the different groups of years. The part of net income paid in taxes ranges from 8.5 to 30 percent.

The method used in arriving at these results is given below.

AVERAGE INCOME, TAXES, AND OTHER EXPENSES PER FARM

	1914–1916	1917–1919	1920–1922	1923–1924
Number of farms	981	721	429	345
Income				
Cash receipts	$1751	$4149	$3210	$3131
House rent	150	150	150	150
Family living	250	400	350	350
Total income	$2151	$4699	$3710	$3631
Expenses				
Cash	$684	$1802	$1870	$1946
Farmer's labor and supervision	500	800	800	500
Wife's labor	100	100	100	100
Family labor	46	129	141	87
Interest on mortgage	132	156	168	150
Depreciation on machinery	50	70	100	100
Depreciation on barns	25	26	25	25
Total expenses	$1537	$3082	$2804	$2408
Net income per farm	$ 614	$ 1617	$ 906	$ 1223
Taxes per farm	85	138	276	199
Percentage net income paid in taxes	13.8%	8.5%	30.5%	16.2%
Average capital per farm	10,784	19,119	26,521	15,731
Interest on investment	5.7%	8.4%	3.4%	7.7%

Receipts.—Cash receipts are relatively easy to obtain but there is no way to get more than an estimate of the value of house rent and of farm products used in the home. Some studies have been made which indicate that the figures used are fairly accurate.

Expenses.—In considering expenses there are a number of items which must be estimated. The wages of the farmer for labor and supervision, and of the wife for labor which contributes to the farm income, such as caring for poultry, must be given a value. This figure for the wife's labor does not of course include her services as housekeeper.

Family labor is used as actually reported and the remaining items are estimated. The farm indebtedness was not reported on many farms. For this reason, it seemed best to use the census figures as a basis for estimating interest paid. The figures given on depreciation are based on studies made in that field.

Taxes.—These records have been grouped into four periods, 1914-1916; 1917-1919; 1920-1922, and 1923-1924. The first was little influenced by war prices, the second is the war period, the third is the depression, and the last a time of recovery. Since there are different farms in these groups in the four periods, taxes should be compared, when expressed, as a percentage of the net income.

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

The year 1925 closed with Ohio agriculture in a better situation than at the close of 1924. In December, 1924 the purchasing power of Ohio farm products was 93, in December, 1925 it was 99. Thus it would seem that the purchasing power of Ohio farm products was nearly back to the pre-war normal. For the United States as a whole the purchasing power of farm products was reported as 87. Still there is a feeling that agriculture is not getting her fair share of the national prosperity. This may be due in part to the fact that the real wages for the average employed worker are now 23 percent greater than they were just before the outbreak of the war in 1914. Thus, while agriculture in Ohio is back to what may be called normal, the wages in other industries have considerably increased.

Since September the general level of prices has tended downward, from 163 to 159. Prices of Ohio farm products on the other hand advanced from 151 in October to 158 in December. Wheat, wool, lambs, and potatoes are among Ohio farm products with the best present prices.

Those who make a business of studying the future course of prices seem to agree fairly well that the first half of 1926 will see a continuation of the present industrial prosperity, which should mean a good demand for farm products. For the latter half of the year the predictions are not so optomistic. Much will depend uoon the profitableness of agriculture.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Ohio farm wages	Non-agriculture products	Farm prices U. S.	Farm prices Ohio	Purchasing power of Ohio farm products
1913	102	......	104	105	100	104	102
1914	100	100	102	97	102	105	105
1915	103	101	103	101	100	106	103
1916	130	114	113	138	117	121	93
1917	181	129	140	182	176	182	100
1918	198	160	175	188	200	203	103
1919	210	185	204	199	209	218	104
1930	230	222	237	241	205	212	92
1921	150	203	164	167	116	132	88
1922	152	197	145	168	124	127	84
1923	156	214	166	171	135	134	86
1924	152	218	165	162	134	133	87
1925	161	......	165	165	146	159	99
1924							
January	155	219	159	177	137	125	81
February	154	218	......	178	136	129	84
March	153	222	......	179	131	127	83
April	151	218	163	180	130	125	83
May	150	217	......	171	129	127	85
June	147	214	......	172	130	126	85
July	150	213	168	169	132	125	83
August	152	216	......	167	139	138	91
September	152	221	......	167	132	139	92
October	155	217	170	165	138	145	94
November	155	218	......	163	137	145	94
December	160	222	......	162	139	148	93
1925							
January	163	223	156	165	146	155	95
February	164	220	......	177	146	155	95
March	164	224	......	165	151	159	97
April	159	218	163	162	147	158	99
May	158	221	......	161	146	162	104
June	160	220	......	163	148	165	105
July	163	220	168	164	149	166	102
August	163	222	......	164	152	163	99
September	163	223	......	163	144	157	96
October	160	225	173	164	143	151	94
November	160	226	.	166	144	157	98
December	159	......	......	165	142	158	99

STATE PURCHASES ADDITIONAL FORESTS

WEEKLY PRESS BULLETIN

"Recent additions bring the total area of Ohio state forests to 19,826 acres, acquired at an average cost of $6.10 per acre," said Edmund Secrest, state forester, as he enumerated the several forests now owned by the State.

During the fiscal year July 1, 1924 to June 30, 1925, tracts totalling 2,373 acres were added to Dean, Pike, and Scioto Trail State Forests, and 890 acres were taken over for forest park uses.

Completed purchases, uncompleted purchases, and options on state forest extensions since July 1, 1925 total 8,482 acres. These are extensions to Dean, Waterloo, Shawnee, Pike, and Scioto Trail Forests. During the same period purchases and options on forest parks amount to 850 acres. To date two tracts of land of 360 acres under option were rejected because of insufficient title.

The average cost of 6,960 acres of state forest lands recently optioned is $5 per acre. Practically all of these areas are stocked with second growth hardwood and pine forests which when put under protection and good management will increase in growth and value each year.

The largest state forest is the Scioto Trail, in Ross County of 6,900 acres, on the Scioto Trail highway; the smallest and one of the most valuable because of a large amount of forest planting is the Waterloo forest of 421 acres in western Athens County.

Each state forest represents a purchase unit, which will be enlarged by acquiring additional land adjacent, whenever opportunity exists.

Every spring trees are planted on the tracts in experimental plantations. Much of this planting is pine.

The Bimonthly Bulletin

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Ohio Agricultural Experiment Station

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Wooster, Ohio, U. S. A.

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BIMONTHLY BULLETIN

OF THE

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FERTILIZERS FOR CORN

ROBT. M. SALTER

Profit in corn growing comes from high yields produced at low cost per bushel. Fertilizers rightly used lower the "per bushel" cost. While the practice of applying most of the manure to the corn ground is well established in Ohio, only in recent years have farmers realized that it pays to supplement the manure with commercial fertilizers. There are, in fact, still many Ohio farms upon which corn gets no fertilizer other than manure and on many of these the manure supply is inadequate to cover all the acreage planted. The result is that many acres of corn get nothing whatsoever. The Ohio Station has abundant evidence from field experiments that manure alone is not an ideal fertilizer for corn, and that, either with or without manure, some commercial fertilizer for this crop is apt to be an excellent investment. What fertilizer to use, how much to use, and how to apply it are questions which warrant consideration in the light of such experimental results as have been secured.

Mixed fertilizers on unmanured land.—Straight acid phosphate may be expected to return a generous profit when applied to corn which gets no manure. The chances are, however, that a mixed fertilizer containing both phosphoric acid and potash will give more net return per acre, and, on thin land without clover, the addition of ammonia in the ferilizer may add still more to its efficiency.

Field tests including the fertilizing of corn have been conducted in 13 counties of the State. These have varied in duration from 7 to 32 years. Table 1 shows the average increases in the yield of corn up to and including the crop of 1924. The increases are given for acid phosphate alone, acid phosphate and muriate of

potash over acid phosphate, and acid phosphate, muriate of potash, and nitrate of soda over the phosphate and potash. In the tests in Cuyahoga and Wayne Counties the corn goes on timothy sod. In all others corn follows clover in rotation. It should be borne in mind that part of the benefit of the fertilizer applied to corn is passed on to the other crops of the rotation, while a part of the increase shown for corn may be due to the residual effect of the fertilizer applied to the small grain crop.

TABLE 1.—Results of Fertilizer Applications to Corn on UNMANURED LAND

County	Soil types under experiment	Duration of test	Fertilizer added			Increase		
			Acid phos.	Mur. of potash	Nit. of soda	For phos-phate	For pot-ash*	For nitro-gen†
		Years	*Lb.*	*Lb*	*Lb.*	*Bu.*	*Bu.*	*Bu.*
Wayne	Wooster silt loam	31	80	80	160	7.49	7.70	5.25
Cuyahoga	Mahoning silty clay loam Trumbull silty clay loam	30	80	80	160	7.17	2.23	2.00
Trumbull	Mahoning silty clay loam Trumbull silty clay loam	9	200	15	45	6.74	1.28	—.19
Mahoning	Canfield silt loam Volusia silt loam	8	200	15	45	6.60	2.02	2.27
Meigs	DeKalb silt loam Meigs silty clay loam	21	120	20	80	8.70	2.20	3.90
Washington	Meigs silty clay loam	10	200	50	50	6.39	1.09	.68
Belmont	DeKalb silt loam	8	200	16	40	6.07	—3.31	1.93
Montgomery	Miami silt loam	21	120	20	80	6.79	5.88	1.71
Hamilton	Miami silt loam Brookston silty clay loam	12	200	50	50	3.72	7.37	.08
Clermont	Clermont silt loam Rossmoyne silt loam	11	200	50	50	7.93	10.96	2.91
Miami	Crosby silt loam Brookston silty clay loam	14	200	50	50	10.34	3.54	-2.36
Madison	Miami silty clay loam Brookston silty clay loam	6	160	46	30	5.93	2.12	-1.00
Hancock	Miami silty clay loam	13	120	20	40	5.52	2.98	—.85
Paulding	Paulding (Brookston) clay	13	200	50	50	—.32	—.64	2.79
	Average...............	15	163	40	66	6.36	3.22	1.36

*Increase is for phosphate and potash over phosphate alone.
†Increase is for nitrate of soda, acid phosphate, and muriate of potash over acid phosphate and muriate of potash.

As an average of all 14 experiments, including 207 yearly trials, 163 pounds of 16-percent acid phosphate, used alone, has given an increase of 6.36 bushels of corn. Figuring corn with its stover worth 70 cents per bushel and acid phosphate at $22 per ton the value of the increase is $4.45 compared to a cost for the fertilizer of $1.79. An average addition of 40 pounds of muriate of

potash to the fertilizer has increased the crop above the phosphate alone by 3.22 bushels worth $2.25 at an additional cost for fertilizer of 92 cents, figuring muriate of potash at $46 per ton. An average addition of 66 pounds of nitrate of soda to the phosphate and potash has increased the crop by another 1.36 bushels worth 95 cents at a cost for the nitrate of $2.26. Used at the average rates indicated, and figured at pure material prices both acid phosphate and potash have given an excellent return on the investment, while nitrogen has been used at a loss. If figured on the basis of prices for commercial mixed fertilizers the combined potash-phosphate application still gives a higher balance above cost than acid phosphate alone. The application given equals 200 pounds per acre of 0-13-10 which would cost, ready mixed, $3.25, or $1.46 more than acid phosphate alone. This compares with a value of $2.25 for the increase produced by the combination over acid phosphate alone.

Acid phosphate has given an excellent balance above its cost in all tests except that in Paulding County, where, on a heavy clay soil, other factors than the supply of plant food elements appear to be limiting the crop. Potash has made a favorable showing in all counties except Cuyahoga, Washington, Belmont, and Paulding. Nitrogen, on the other hand, has failed to pay for itself except in three counties, Clermont, Mahoning, and Paulding, and in these the value of the increase has exceeded the cost of the nitrogen by only a few cents per acre.

In all of these tests the additions of potash have been made without reducing the application of phosphoric acid, while the nitrogen has in all cases been added without reducing either the phosphate or potash. In an 11-year test at Wooster the plan is followed of adding potash to the fertilizer by substituting it for an equivalent amount of phosphoric acid, while additions of nitrogen are made at the expense of both the phosphoric acid and potash. This test is upon limed and drained land.

Table 2 shows the fertilizer application made to corn, the 11-year average increases, the value of the increase, the cost of the fertilizer figured at present prices for commercial mixed fertilizers, and the balance derived by subtracting the cost of the fertilizer from the value of the increase.

Replacing 4 percent of the phosphoric acid in 16 percent acid phosphate with an equal amount of potash, making an 0-12-4, has produced a larger increase in yield and a larger money balance. When, however, the phosphoric acid is further reduced by 4 percent

and the potash by 2 percent and 2 percent of ammonia is introduced the money balance is reduced below that from straight acid phosphate. Apparently, for corn following clover on this limed Canfield silt loam soil a fertilizer carrying phosphoric acid and potash is preferable to either straight acid phosphate or a 2-8-2 fertilizer.

TABLE 2.—Effect of Fertilizers on Corn in a 4-Year Rotation of Corn, Oats, Wheat, Clover at Wooster

Plot	Analysis of fertilizer	Amount per acre on each crop	11-year average increase	Value of increase	Cost of fertilizer	Balance
No.		*Lb.*	*Bu.*	*Dol.*	*Dol.*	*Dol.*
2	0–16–0	250	9.26	6.48	2.75	3.71
3	0–12–4	250	12.74	8.90	3.44	5.46
5	2– 8–2	250	9.70	6.79	3.68	3.11

Acid phosphate with manure.—Thorne estimates that a ton of mixed open yard manure from horses and cows will carry about 11 pounds of ammonia, 5 pounds of phosphoric acid, and 8 pounds of potash. Results of fertilizer experiments show that, to be most efficient, a fertilizer for general farm crops on Ohio soils should contain more phosphoric acid than either potash or ammonia. This fact suggests that a combination of manure and acid phosphate is a better balanced fertilizer for corn than manure alone. Several field experiments are in progress at Wooster in which the merits of the manure-acid phosphate combination have been amply demonstrated. These tests have been running from 11 to 28 years. The average yields of corn secured in several of these tests during the last 5 years are shown in Table 3. Apparently the consistent use of manure and acid phosphate on corn in a rotation including clover once in three or four years may be expected to maintain the yield at a level approximately double the average for the State.

How much fertilizer?—The most desirable rate of fertilizing any crop depends considerably upon the treatment given the preceding crops of the rotation. This is true because of the "hold over" effect of applications of potash and phosphoric acid. In field experiments at Wooster it has been found profitable to use up to 250 pounds per acre of acid phosphate or high grade mixed fertilizer for each year of the rotation. This does not mean that it is best for the fertilizer to be divided equally among the crops grown. In an 11-year test at Wooster 1000 pounds of 2-8-2 fertilizer divided equally among the crops in a 4-year rotation of corn, oats, wheat, clover has given increased crops which were lower in value by 12

percent than where the same total amount of fertilizer was applied to the corn and wheat only. Where grown in a rotation including wheat a safe practice should be to apply ⅓ of the total fertilizer to the corn crop and the remainder to the wheat. Where oats is the only small grain grown the corn crop may well receive a larger share of the total fertilizer. In general, the proper fertilizer application on corn will vary from 200 to 400 pounds per acre depending upon the fertilizer used, the soil, and the distribution of the fertilizer among the crops of the rotation.

TABLE 3.—Manure and Acid Phosphate on Corn at Wooster (All Tests on Limed and Drained Land)

Crop rotation	Duration of test	Treatment on corn		Average yield 1921—1925
		Manure	Acid phosphate	
Manure Test	*Years*	*Tons*	*Lb.*	*Bu.*
Corn, wheat, clover...........	28	None	None	40.0
Corn, wheat, clover...........	28	8 (Yard)	None	64.6
Corn, wheat, clover...........	28	8 (Stall)	None	70.7
Corn, wheat, clover...........	28	8 (Stall)	320	78.4
Fry Farm				
Corn, oats, wheat, clover......	11	8	480	75.1
Variety Range				
Corn, oats, wheat, clover.....	22	10	300	79.1
Livestock Rotation				
Corn, soybeans, wheat, clover	16	16½	400	86.0

Shall we fertilize in the hill?—Arguments have been advanced against putting the fertilizer in the hill or row for corn. The practice has been charged with limiting the root growth, with the danger of firing, with uneven growth of the small grain following the corn, and with a tendency on the part of the farmer to reduce the total fertilizer applied per rotation. Nevertheless there are farmers, good ones, who till the poorly drained clay soils of northeastern Ohio or the equally poorly drained "white clays" of southwestern Ohio who maintain that putting a little high grade mixed fertilizer in the hill helps to start the crop off and overcome the disadvantage of late planting, so often necessary on these cold, wet soils. Unfortunately the question needs further investigation in Ohio before it can be accurately answered.

Recent work at the Michigan, Wisconsin, and Iowa stations has shown that fertilizing in the hill does not restrict root growth, that when precautions are taken to prevent the seed and the fertilizer coming into direct contact germination is not affected, that maturity may be advanced as much as a week or more, and that when

properly applied there is little danger of firing the crop with less than 200 pounds of the ordinary grades of mixed fertilizers. At the Wisconsin Station in 13 direct comparisons of equal amounts of acid phosphate or 2-12-2 placed in the hill and broadcast, the yield for hill fertilizing led by an average of 5.3 bushels, while in only two instances did the corn fertilized broadcast exceed that fertilized in the hill. However, conclusions in favor of row fertilizing cannot be safely drawn without knowing the effects of the treatments on the following crops of the rotation, and these have not been reported.

An experiment was started at Wooster in 1922, which includes a comparison of 375 pounds per acre of 4-16-4 applied broadcast to corn with an equal amount applied in the row, with 100 pounds in the hill and 275 pounds broadcast, and with 100 pounds in the hill without any broadcast application. The corn is followed by wheat and clover in rotation, the wheat getting in each case, 375 pounds of 4-16-4 fertilizer. Due to the short period covered by this work, the data given in Table 4 should be considered as indicative rather than conclusive.

TABLE 4.—Hill vs. Broadcast Application of Fertilizers for Corn at Wooster

Plot	Fertilizer on corn	Application		Increase due to fertilizer		
		Broadcast	In hill	Corn (3 crops)	Wheat (2 crops)	Clover (1 crop)
No.		*Lb.*	*Lb.*	*Bu.*	*Bu.*	*Lb.*
9	4—16—4	375	....	8.03	14.83	240
11	4—16—4	....	375	6.16	16.29	730
12	4—16—4	275	100	10.81	17.55	740
15	4—16—4	....	100	9.27	14.29	300

Hill fertilizing of corn may be advisable with late planting, particularly on heavy land, providing the total fertilizer used in the rotation is not reduced. The treatment given should probably be around 100 pounds of high grade mixed fertilizer such as a 3-12-4 in the hill supplemented with a broadcast application of 150 to 250 pounds per acre of acid phosphate or 0-14-4 depending upon whether or not manure is used.

Fertilizing corn with clover.—A discussion of fertilizers for corn would scarcely be complete without calling attention to the effect of clover upon the crop. In the tests reported in Table 1 corn is grown in rotation with clover, which it follows in all but two cases. The poor showing of fertilizer nitrogen in all cases is probably due to the nitrogen supplied by the clover crop. It seems

doubtful whether nitrogen should ever be included in the fertilizer applied broadcast to corn where clover is grown regularly in rotation.

Farmers are rapidly learning to use sweet clover as a green manure for corn. Recent experiments on the Paulding County farm emphasize the value of this practice. As a 4-year average the inclusion of sweet clover as a plow-down crop for corn in a 2-year rotation of corn and oats increased the yield of corn from 31.3 to 49.4 bushels per acre and the oats following from 40.9 to 49.9 bushels per acre. It will be recalled that commercial fertilizers have been relatively ineffective on this soil. This raises the question whether sweet clover may not have some special value in opening up these heavy soils in addition to supplying nitrogen to the crop.

TABLE 5.—Suggested Use of The Ohio Standard Fertilizers on Corn

Kind of soil	Other treatment		
	Manure	Clover	Neither
Sands	Phosphate*	2-12-6	3-12-4
Other light colored soils	Phosphate*	0-14-4	2-12-6
Peats and mucks	0-14-4	0-10-10	2-8-16
Other dark colored soils	Phosphate*	0-14-4	0-14-4

*By phosphates are meant acid phosphate, bone meal, or basic slag.

Suggested use of the Ohio standard fertilizers on corn.—Seventy-five percent of the mixed fertilizers now sold in Ohio are included in a list of eight high-grade analyses which, together with the phosphates and other pure materials, are known as "The Ohio Standard Fertilizers". The use of these standard fertilizers on corn suggested by agronomists of the Ohio College of Agriculture and the Ohio Experiment Station is shown in Table 4. The recommendations are not in all cases supported by direct field experiments but represent the consensus of opinion, based upon all available field experiments, as to what constitutes a proper treatment for the crop.

Column "manure" assumes that 8 tons or more of well preserved manure is used on the corn crop. Column "clover" assumes that a good clover sod is plowed down at least once every four years. Column "neither" assumes that manure is not used on the crop and that clover has not been grown systematically in rotation. These analyses are suggested on the basis and with the recommendation that a yearly average of 200 pounds or more per acre be used during the rotation.

ALFALFA AND SOYBEAN HAY FOR GROWING HEIFERS

C. C. HAYDEN

The results of a comparison of alfalfa hay and clover hay for growing dairy heifers were given in the Bimonthly Bulletin for July-August, 1925. The heifers fed either of these hays *liberally*, supplemented with corn, made excellent growth, even larger growth than is commonly called normal. Alfalfa hay appeared to be superior to clover hay but the difference was small. The results of a similar comparison of alfalfa hay and soybean hay for growing heifers are presented in the following article.

Six heifers, two Holstein and one Jersey in each of two lots, were used in this experiment. Pictures of the heifers at the end of the first test, July 13, and their weights and heights at the withers at the beginning and ending of this test are given on pages 100 and 101. Other data are given in Table 1.

TABLE 1.—Data Concerning Heifers Used

Lot I Alfalfa Hay					Lot II Soybean Hay				
Herd No.	Breed	Age	Weight	Height at withers	Herd No.	Breed	Age	Weight	Height at withers
		Mo.	*Lb.*	*In.*			*Mo.*	*Lb.*	*In.*
263	H. F.	12	645	46.25	264	H. F.	10½	606	44.00
268	J.	8¼	377	39.75	265	J.	9⅓	450	43.00
269	H. F.	7½	467	42.50	270	H. F.	7⅓	471	41.75
Average	....	9¼	496	42.83	....	....	9	509	42.91

The ration consisted of one part of ground corn to two parts of hay, by weight, and any straw that they may have eaten from their bedding. Lot 1 received the corn and alfalfa hay; Lot 2, corn and soybean hay. The comparison of alfalfa and soybean hay started January 1 and ended July 13, 1923, 194 days.

The results, as summarized in Table 2, show slightly greater average gain in weight and slightly less feed consumed per pound of gain by the heifers in Lot 2 on soybean hay and corn. The heifers in Lot 1 on alfalfa hay showed greater average gains in all measurements, except length, which is the least significant of the measurements. While the average growth was greater for the lot on alfalfa, the greatest individual increase over normal was made by Jersey heifer, No. 265, on the soybean hay.

A probable explanation for the smaller consumption of feed per pound of gain by the heifers in Lot 2 is found in the fact that they failed to eat many of the coarse stems of the soybean hay and, this refuse not being charged to them, they actually ate less than the heifers of the other lot, which cleaned up all the alfalfa hay.

TABLE 2.—Average Gains and Feeds Consumed Per Pound of Gain, 194 Days

	Lot I Alfalfa hay	Lot II Soybean hay	Difference
Average gain in weight	265.00 lb.	277.70 lb.	—12.70 lb.
Average daily gain	1.37 lb.	1.43 lb.	—.06 lb.
Hay per pound gain	6.95 lb.	6.75 lb.	.20 lb.
Corn per pound gain	3.47 lb.	3.31 lb.	.16 lb.
Gain in height at withers	4.92 in.	4.62 in.	.30 in.
Gain over withers	11.43 in.	11.17 in.	.26 in.
Gain in height at hook bones	5.25 in.	4.37 in.	.88 in.
Gain over hook bones	13.08 in.	11.25 in.	1.83 in.
Gain in heart girth	10.12 in.	9.83 in.	.29 in.
Gain in length*	13.42 in.	13.83 in.	—.41 in.

*Poll to end of tail—not very significant, difficult to get accurately.

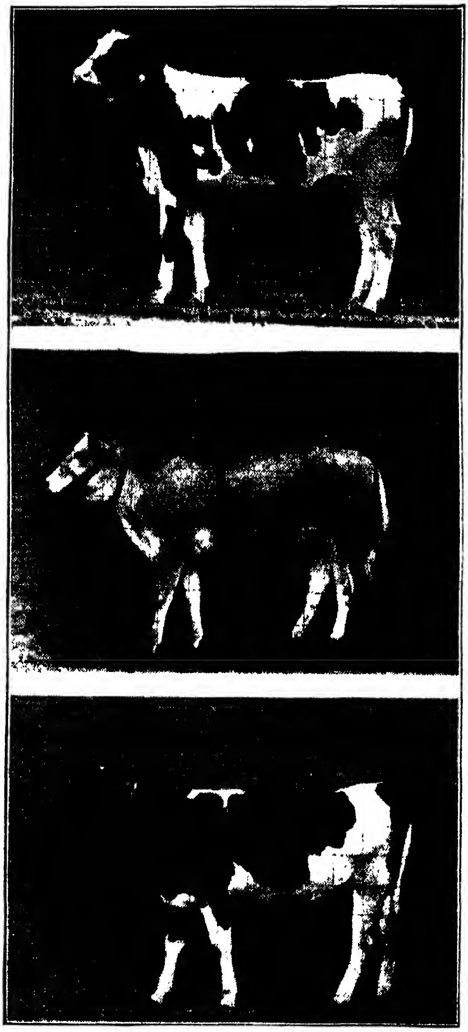
One of the heifers receiving soybean hay, was off feed for a few days, probably due to slight indigestion caused by the coarse stems of the hay. Otherwise, there was no observable difference in condition of the animals of the two lots.

Height at withers is considered the least variable of measurements and therefore the best measure of growth. The measurements at close of test, compared with normal height for age and breed as determined by C. H. Eckles, chief, Division Dairy Husbandry, University of Minnesota, and published in Research Bulletin 36 of the University of Missouri, are shown in Table 3. All six heifers in this experiment exceeded the height considered normal.

TABLE 3.—Age, Height at Withers, and Differences at Close of Test, July 13

	Heifer	Age	Height	Normal	Above normal
	No.	*Mon.*	*In.*	*In.*	*In.*
Lot 1 Alfalfa hay and corn	263	18.5	50.25	47.95	2.30
	268	14.5	45.50	44.06	1.44
	269	14	47.50	46.22	1.28
Lot 2 Soybean hay and corn	264	17	48.25	47.65	.60
	265	16	47.25	44.65	2.60
	270	14	47.12	46.22	.90

The differences in growth as shown by these measurements were not great, but they indicate that alfalfa hay is slightly superior to soybean hay in the development of dairy heifers. However, the fact that the heifers in each lot averaged above normal, shows that either hay fed liberally with corn contains sufficient protein of proper quality to permit excellent growth.



Alfalfa Group
Heifers as they appeared on
July 12, 1923

No. 263, Holstein

Weight January 1,	645	lb.
Weight July 13,	891	lb.
Gain	246	lb.
Height January 1,	46.25	in.
Height July 13,	50.25	in.
Gain	4.00	in.
Above normal	2.30	in.

No. 268, Jersey

Weight January 1,	377	lb.
Weight July 13,	584	lb.
Gain	207	lb.
Height January 1,	39.75	in.
Height July 13,	45.50	in.
Gain	5.75	in.
Above normal	1.44	in.

No. 269, Holstein

Weight January 1,	467	lb.
Weight July 13,	809	lb.
Gain	342	lb.
Height January 1,	42.50	in.
Height July 13,	47.50	in.
Gain	5.00	in.
Above normal	1.28	in.

No. 264, Holstein

Weight January 1,	606	lb.
Weight July 13,	970	lb.
Gain	264	lb.
Height January 1,	44.00	in.
Height July 13,	48.25	in.
Gain	4.25	in.
Above normal	.60	in.

No. 265, Jersey

Weight January 1,	450	lb.
Weight July 13,	703	lb.
Gain	253	lb.
Height January 1,	43.00	in.
Height July 13,	47.25	in.
Gain	4.25	in.
Above normal	2.60	in.

No. 270, Holstein

Weight January 1,	471	lb.
Weight July 13,	787	lb.
Gain	316	lb.
Height January 1,	41.75	in.
Height July 13,	47.12	in.
Gain	5.37	in.
Above normal	.90	in.

Soybean Group
Heifers as they appeared on
July 12, 1923

This large skeletal growth may have been due to some extent to the abundance of calcium and vitamins in each of the hays; but, perhaps a more important factor was the inherited growth impulse, or these heifers, which were in excellent order at the close of the test, may have been fed more liberally than those used by Eckles in determining normal growth. The average weights of heifers grown in the Station herd are greater than those given by Eckles, but measurements are not available for comparison. These heifers exceeded the herd average in weight.

PART II

The plan was to discontinue the test when the supply of soybean hay was exhausted, which was July 13, 1923. However, as the heifers were doing well, they were continued on legumes and corn until the following spring. The comparison of alfalfa and soybean hay was discontinued.

Lot 1 continued to receive alfalfa hay until the supply was exhausted, August 26. Clover hay was then substituted for five days, then new soybean hay until September 16, after which alfalfa hay was again fed.

Lot 2 was changed from soybean hay to alfalfa hay, which was fed from July 14 to August 21, after which new soybean hay was fed to November 30, and alfalfa thereafter. Not having planned for a feeding test during this period, sufficient hay was not available to prevent these numerous changes.

When the hay fed to Lot 1 was changed to clover, then to soybeans, in August, the heifers lost in weight, but quickly recovered and made the usual gains. When Lot 2 was changed to alfalfa, July 14, there was no decrease in weight; but, when changed back to soybean hay in August they lost in weight, as did Lot 1. However they recovered quickly and made good gains. Changes from soybean to alfalfa hay caused little or no change in rate of gain, while changes from alfalfa to clover or soybean hay caused considerable loss in weight followed by quick recovery.

Weights at the close of the test and total and daily gains are shown in Table 4. All show heights above normal for heifers of the same breed and age fed in the ordinary manner. In this the results were similar to those in the test comparing alfalfa and clover hay as previously mentioned. No undesirable effects due to the limited sources of protein were noted.

The heifers were bred as follows: Heifer 263 (H. F.), once and on April 7 dropped a calf weighing 84 pounds. Heifer 268 (J), a freemartin, was taken from the test on November 12. Heifer 269 (H. F.), once and conceived but was sold at the close of the test and before calving. Heifer 264 (H. F.), once and on May 12 dropped a calf weighing 83 pounds. Heifer 265 (J), twice and on May 17 dropped a calf weighing 55 pounds. Heifer 270 (H. F.), three times and on November 19 dropped a calf weighing 107 pounds. This shows that the heifers were served about the normal number of times for heifers in the herd at that time.

TABLE 4.—Age, Weight, and Height at Withers at Close of Last Test and Gains for Entire Period

	No.	Date	Age	In test	Weight	Gain	Daily gains	Height at withers	Normal height at withers	Above normal
			Mo.	*Da*	*Lb.*	*Lb.*	*Lb.*	*In.*	*In.*	*In.*
Lot I	263	Apr. 1	30	413	1,253	558	1.351	53.50	51.46	2.04
	269	May 20	24.5	506	1,190	723	1.428	51.00	50.30	.70
	268	Oct. 31	....	304	624	247	.812	....	....	....
Lot II	264	May 20	27	506	1,190	584	1.154	51.50	50.18	1.32
	265	May 1	26.5	500	995	545	1.090	49.25	47.88	1.37
	270	May 1	24.5	499	1,193	722	1.447	51.75	50.30	1.45

CONCLUSIONS

1—The results show alfalfa hay to be a little superior to soybean hay and the previous test showed alfalfa hay a little superior to clover hay for growing heifers when *liberally* fed with corn.

2—Alfalfa, clover, or soybean hay *liberally* fed with corn is capable of supporting better than so-called normal growth.

3—The alfalfa was cleaned up well, but the heifers refused a considerable amount of the coarse stems of the soybean hay.

4—Where legume hays and corn are available, greater variety of proteins or high protein grains do not seem necessary to grow choice heifers.

FROST INJURY TO THE APPLE

FREEMAN S. HOWLETT

Frost injury to the developing flowers and young fruits of the apple is often encountered in certain of the fruit growing districts of Ohio and other states. The likelihood of injury at a given low temperature depends in part upon the stage of development of the flowers and young fruits as well as upon the temperature itself. The evidence in horticultural literature indicates that as the flowers advance in their development the critical temperature for injury becomes somewhat higher. Flowers which are still closed but are showing pink may be injured by temperature from 25° to 27° F., while the lowest safe temperature in full bloom is 29° F. When the fruit is setting, injury may occur from 28° to 30° F. However, flowers on the same tree and alike in development will show differences in resistance to the same temperature as will flowers on different trees of the same variety and of different varieties.

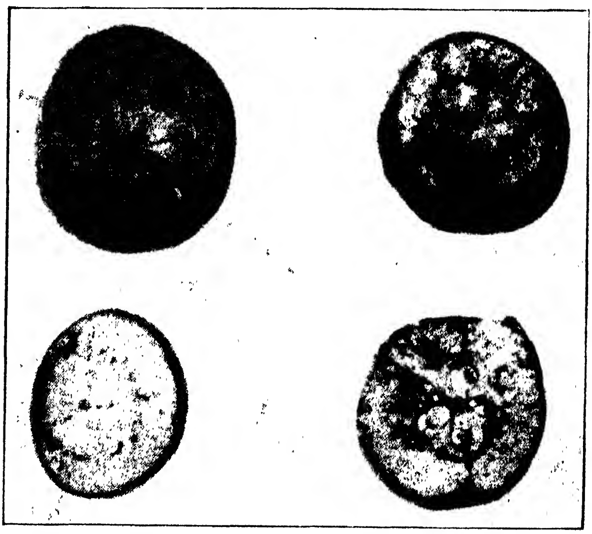


Fig. 1.—Frost injury in developing fruits of variety Baldwin June 17, 1925

Because of the greater differences in time of blooming of the varieties of the apple than of varieties of most other fruits, the possibility of breeding late-blooming varieties, which would escape the late spring frosts, looks very favorable. Some known late-blooming varieties are Ralls, Ingram, Williams, Northern Spy, Mother, Rome Beauty, Red Rome, and Gallia Beauty.

At Wooster on the night of May 24-25, 1925, the temperature registered on a minimum thermometer in the orchards was 28° F. There is no doubt that it was somewhat colder in lower parts of the orchards. However, the number of flowers surviving the frost and the generally satisfactory size of crop harvested indicate that the temperature did not fall far below 28° F. The young fruits which had set at the time of the frost were 1/4 to 1/2 inch in diameter. At points along Lake Erie the injury was much more severe and the crops were seriously reduced because of the lower temperatures.

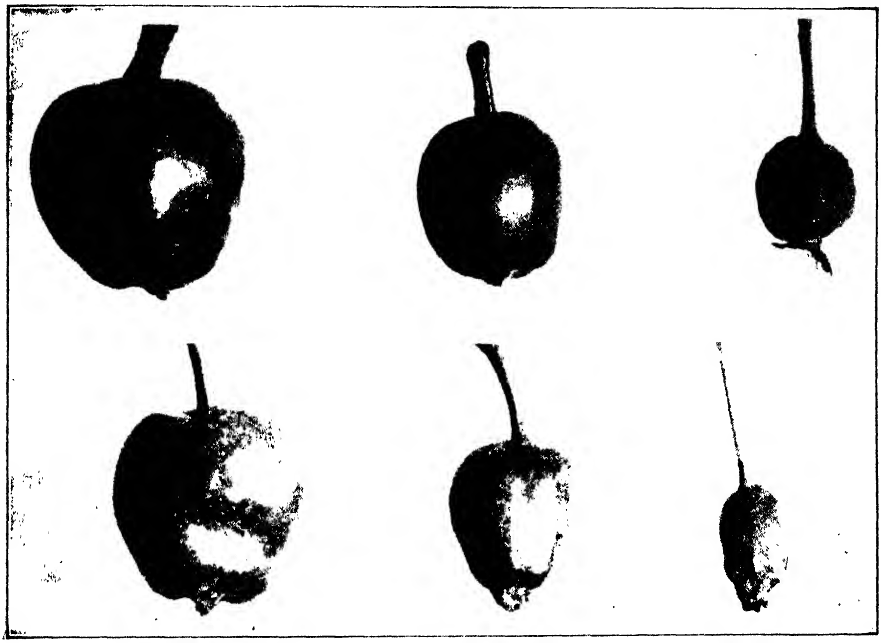


Fig. 2.—Comparison of developing fruits with second and third drop fruits—June 17, 1925
In order: developing fruits; third drop fruits; second drop fruits
Upper row—Baldwin
Lower row—Delicious

A study of the falling fruits of forty varieties of apples, during the period between the frost and harvest, indicated several points of interest in connection with frost injury to young fruits and its effect upon their subsequent growth.

NORMAL DROPS

In the apple in a normal season there are two distinct drops of flowers and partially developed fruits. The first, one to three weeks after petal fall, is made up of flowers and slightly developed fruits. An examination of these drops indicates that there has

been little or no change in the ovary and surrounding tissue since the flowers were in full bloom. The second drop, two to three weeks later (about the middle of June at Wooster), is made up of partially developed fruits. In practically all cases, these fruits show some development of seeds, which, even tho slight, indicates that the flowers from which they developed had been fertilized.

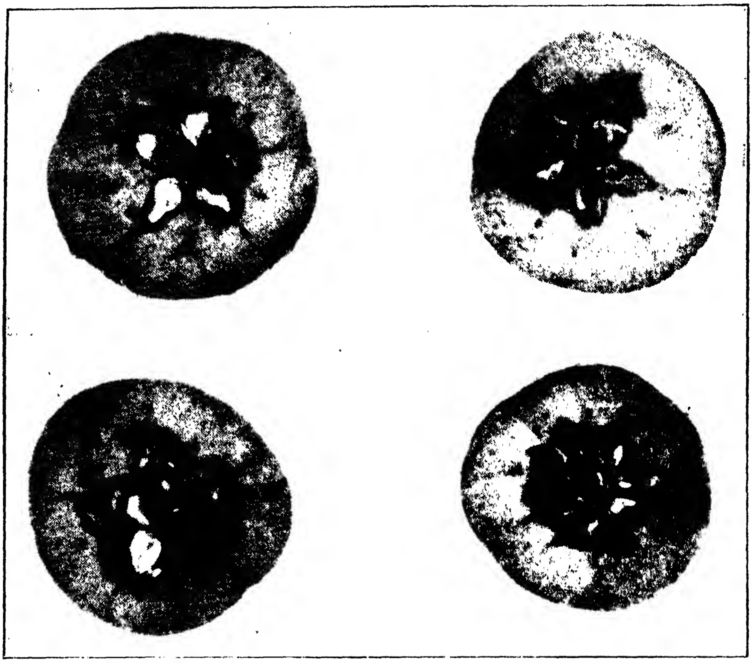


Fig. 3.—Frost injury in partially developed fruits which had fallen. Variety—McIntosh (enlarged) June 23, 1925

Investigators have come to believe that this "June drop" is associated with nutritional causes. There is usually some relation between the size of the first drop and that of the "June drop". The "June drop" is relatively small in amount when the first drop is large. However, if a large proportion of flowers start to develop into fruits, instead of falling at the first drop, the "June drop" will be heavy.

DROPS IN 1925

In 1925 the first drop preceded the frost. Instead of one subsequent drop, there were two fairly distinct waves of dropping. The first of these, or the second drop, in large part, comprised partially developed fruits injured by the low temperature. The third drop included not only distinctly frost-injured fruits but also fruits that could not be distinguished from the "June drop".

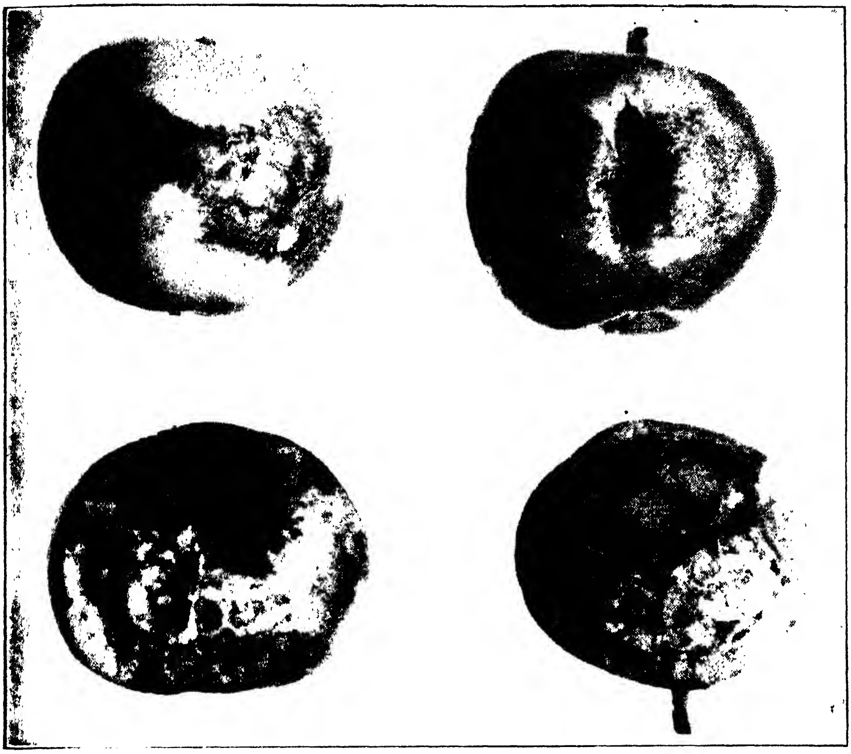


Fig. 4.—Upper row—"Ring type" of frost injury on developing fruits; variety—Steward
Lower row—Injury in flesh of developed fruits; variety—Milwaukee—June 27, 1925

Second drop.—The second drop, beginning about June 3, was made up of young fruits $3/8$ to $5/8$ inch in diameter. The fruits were somewhat wilted and the seeds in the majority of them were discolored but not always shrunken. This was particularly true of Delicious, Winter Banana, Maiden Blush, Fameuse, Jonathan, Grimes, Baldwin, and Wilson's Red June. Altho some falling fruits showed no seed discoloration they exhibited distinct browning of the flesh in the core region. The greater number of fruits of McIntosh and Ben Davis showed no discoloration of the seeds nor injury to the flesh at the time of falling. At this time many fruits with visible browning of the skin, or brown areas under the skin, in the flesh of the core region, or along the vascular system, were still holding firmly to the tree. A few fruits were observed in which all seeds in one or two of the core cavities had been killed but which were, nevertheless, increasing in size. The growth of these fruits was largely on the side of the uninjured seeds.

Third drop.—On June 12 to 16 it was observed that many of the fruits showing only a browning of the flesh under the skin, along the core line, and in the vascular threads thru the flesh, were increasing in size. Many of these fruits remained on the tree until maturity and resulted in mal-formed fruits at harvest time. This was particularly true of the varieties, Steward, Red June, Fameuse, Ohio Nonpareil, Baldwin, Rhode Island, Stark, Moyer, Mother, and Milwaukee. See Figures 1 and 2.

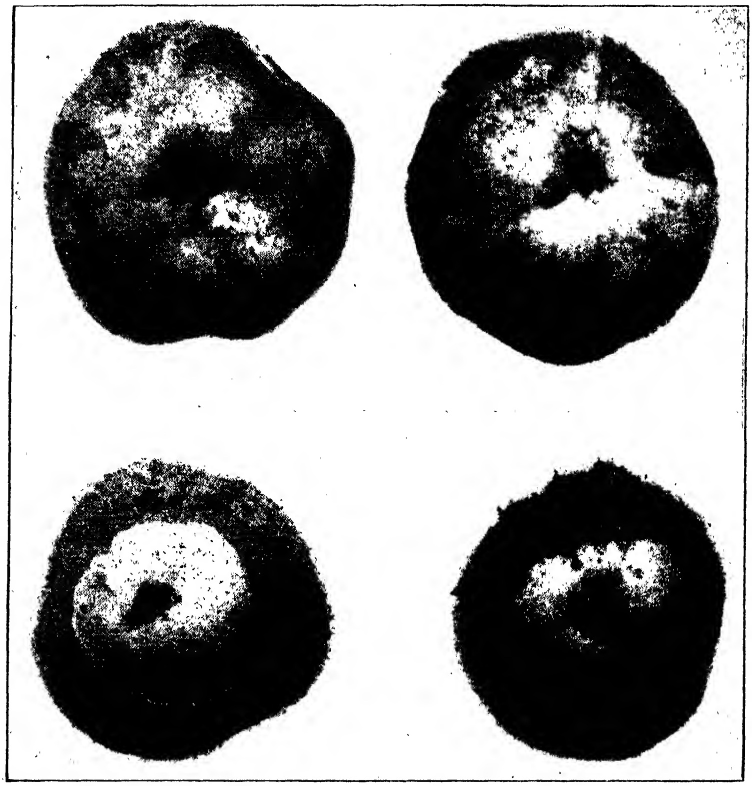


Fig. 5.—Upper row—An unusual type of frost injury on developing fruits
Lower row—"Ring" type of frost injury on developing fruits

The fruits that fell at this drop averaged ¾ to 1 inch in diameter, which indicated appreciable development. See Figures 2 and 3. Altho many of them showed at least a slight discoloration of the seeds or inner core region, yet many others gave no visible evidence of frost injury. Altho in some varieties (Maiden Blush, Baldwin, Delicious, Oliver, Ben Davis, Jonathan, and McIntosh) the number falling at this time was rather large, the number left was

sufficient to give a fairly satisfactory crop. In others (Tompkin's King, Munson Sweet, and Rhode Island) the number of fruits falling was not large, but they were falling from spurs upon which only one or two fruits had survived the second drop. This thinned the trees very decidedly.

GENERAL CONSIDERATIONS

The frost caused severe injury to many partially developed fruits. Many fell in two rather distinct waves, while others remained on the trees until maturity. Fruits showing common as well as unusual surface frost injury are illustrated in Figures 4, 5, and 6.

Fig. 6.—Calyx-end type of frost injury on developing fruits uly 16, 1925

It was evident from the study that many partially developed fruits, which had no discoloration of the seeds or of the flesh, fell in the second and third drops as a result of the frost injury. However, when even a slight discoloration of the seed was noticeable, the fruit so injured usually dropped. Fruits with only the flesh injured, did not fall in a very great number of instances. Often with browning of the core line as well as of the vascular system, and occasionally despite the killing of seeds on one side of the fruit, development continued, resulting in many mal-formed fruits at maturity. It was also evident that many fruits which made additional growth after the frost had been injured and eventually fell as a result.

PEACH DISEASE CONDITIONS IN OHIO

L. R. HESLER

Inquiries from Ohio growers regarding diseases of the peach seem to be on the increase. This may be due to a number of causes: (1) a heightened interest, on the part of farmers and plant pathologists, in the business of peach-growing; (2) a resultant sharpening of the grower's observation, leading to the discovery of troubles, some of which have hitherto escaped his attention; (3) a slight shift in the management of the crop; and (4) rather unusual winter weather conditions. These factors, and doubtless others, are involved in the attempt to nurse along this naturally delicate and short-lived tree-crop in order to meet an increasingly keen competition in peach production.

Altho peaches have been grown commercially in Ohio for years, it appears that the gamut of orchard practices has not until recently been fully applied. Now, however, to cultivate, fertilize, prune, and spray are fast becoming a part of the program. It is well-understood, of course, that spraying is directed toward pest control. But a fact often overlooked is that the other practices mentioned also have some bearing on the problems of disease control.

The peach is subject to disease thruout its whole life. No part of the tree escapes this liability: the roots may suffer from crown-gall and root-rot; the woody portions above ground are subject to winter injury, brown-rot cankers and twig blight, scab, black spot, and the general condition of gum-flow, known as gummosis. Practically every season brings up a different disease or a different form of some disease of the previous season. Winter-killing takes place when the temperature is severe; the leaves on expanding from the bud may develop curl, particularly if damp weather prevail at bud-swelling; the blossoms may blight from attacks of the brown-rot fungus; subsequently twigs and their leaves may die from direct attack of the brown-rot fungus or from the effect of severe cold of the preceding winter; twigs may also die during early and mid-summer as a result of girdling caused by the brown-rot fungus; the fruits, from their time of setting, are subject to brown-rot, scab, black-spot, and pustular spot. During the spring and summer the curl, brown-rot, and scab fungi establish themselves about the tree in preparation for hibernation and for a new campaign the following year.

Meantime, in the average commercial orchard, a program of cultivation, pruning, fertilization, and spraying has been carried forward. The amount of trouble experienced with the several diseases mentioned varies with these practices.

SPRAYING

Spraying for leaf curl.—Fall spraying is recommended for peach leaf curl. Formerly spring application was practiced but the difficulty of getting on the orchard at a timely season has lead plant pathologists to investigate the effectiveness of fall spraying. Results from fall spraying for curl have proved entirely satisfactory. Growers are cautioned against applying the spray too soon after the leaves fall. No fall spraying should be done until after a good freeze, thus allowing time for the new growth to become hardened against the possibility of twig-killing by strong spray. The spray still recommended is lime-sulphur solution 1 part to water 15 parts, or dry lime-sulphur 6 pounds to 50 gallons. Where scale is present, double the strength. These sulphur sprays are superior to the oils against peach leaf-curl. Freedom from curl in one year does not guarantee its absence the following spring Curl will develop on leaves from unsprayed buds any year when the weather is damp at bud-swelling. It is unnecessary to spray more than once for curl; assuming an application was made in the fall as suggested, another spray for curl in the spring before the buds swell is not necessary. Poisons for insects need not be added when spraying for curl.

Summer spraying.—The important features in spraying the peach are similar to those involved in spraying any other fruit. They are time and number of applications, materials to use, and thoroness.

A maximum of four summer sprays will control the ordinary diseases that are at all amenable to spraying. In dry seasons and on earlier varieties, the number of summer applications may be reduced to three. On stone fruits generally a "pink" spray is not important in Ohio as it is on the apple. Unless conditions change, a pre-blossom spray is not necessary under Ohio conditions. If, however, brown-rot breaks out during any summer, and if the weather is particularly damp and favorable at the next blooming period, some trouble from brown-rot blossom blight may be expected. The first summer application is made after the bloom has fallen when the husks on the young fruits are shedding. Three subsequent sprays are advisable: at two-week intervals if the weather is

wet, and at three-week intervals if dry. The last application, made two to three weeks prior to picking, is important in that, even if no rot has yet developed, the disease may be prevented on the ripening fruit. Fruits withstand shipment better where this final spray is applied than where it is omitted.

The whole problem of "market pathology" can not be discussed here, but a single suggestion may suffice. Let it be assumed that fruit is kept free from rot until picking. The spores of the brown-rot fungus, common in every orchard, float about and eventually some of them come to rest on the surface of the peaches. Carelessness in handling the fruit incident to picking, packing, and shipping may result in injury thru which the rot fungus may then enter. The rot disease ensues, making itself most conspicuous perhaps at the critical point, the retail market.

The material now generally recommended and used in Ohio for summer spraying is dry-mix sulphur-lime. This is a dry material, but is added to water and applied with a sprayer. The dry-mix may be purchased already mixed, or the materials may be purchased separately and mixed at home. The formula follows:

Sulphur, superfine	6 pounds
Hydrated, or mason's, lime	3 pounds
Kayso	2 ounces
Water to make 50 gallons	

The Kayso may be displaced in the formula by ground glue which is dissolved in hot water. In either formula, arsenate of lead is usually added to all summer sprays except the last at the rate of $1\frac{1}{4}$ pounds powder or $2\frac{1}{2}$ pounds paste to 50 gallons of the spray. The arsenate of lead controls curculio, which not only punctures and mars the fruit but also carries the brown-rot fungus. Controlling the curculio, therefore, is important in the suppression of brown-rot. Sometimes growers complain of the rot when curculio injury is not in evidence. It should be remembered that the spores of the rot fungus may be disseminated thru the air and thus cases of brown-rot may develop even in the absence of curculio. In most cases that we have observed the rot starts in a curculio injury.

Sulphur dust, 80-10-10, has been used as a summer fungicide for peaches. In general this dust seems to be satisfactory when applied at the approximate time that sprays would be applied. For the last application an 80-20 dust, without lead arsenate, is used.

Thoroness of application is essential to disease control. Sprays and dusts are applied in order to protect against fungi, and the film of toxic material must completely cover the portions to be protected.

SPRAY INJURY ON PEACHES

Two forms of spray injury are common on peaches in Ohio. Both are from the use of arsenate of lead; one appears on leaves and the other on twigs.

Spray injury on leaves.—No cases of this type of an alarming nature have come to attention. The injury appears as a brown, circular, dead area one-fourth to one-half an inch in diameter, or as a narrow strip of dead tissue along the leaf margin. These dead areas frequently break away from the living portion of the leaf, causing a ragged appearance, or "shot-hole". This type of spray injury on peach leaves casually suggests the bacterial leaf-spot with which it is sometimes confused. The bacterial spots, however, begin as very small water-soaked areas, soon show gray color, and are angular in form. Later these lesions become brown or purple-brown, in which condition they are confused with spray injury. The bacterial spots are much smaller in this condition than the spray-injured areas. The history of the development and the size and shape of the injured portions are important means of distinguishing the two troubles. Leaves severely affected by the spray usually fall, while those less heavily affected remain on the tree thruout the season.

Spray injury on twigs.—Apparently this type of injury has been largely overlooked. It appears on trees that have been sprayed or dusted with materials containing arsenate of lead. Unsprayed trees have failed to exhibit cankers similar to those on sprayed trees. On new growth the injury ordinarily appears at the buds. In more severe cases it also shows on the internodes altho somewhat less defined. The injured area may be described as a well-defined canker in which the bark is dead and brown. Generally these cankers are superficial, from $1/8$ to $3/8$ inch in diameter, and about half encircle the twig. Similar injuries may be found at the base of the new growth. Cracking and gumming do not seem to be characteristic of these injuries on young trees. On one-year-old twigs they show as dead blotches, the bark from which may crack and partly slough off leaving a ragged appearance. Apparently the cambium may at times be killed by arsenical sprays—such a type of injury is reported from New Jersey (Phytopathology 15, pp. 321-331, 1925). Where the bark cracks open gum may ooze forth. The serious and more common cases of gummosis in Ohio, however, do not appear to result from spray injury. Whether twigs are killed outright by the use of arsenicals is not yet fully

determined for Ohio orchards, but thus far all cases of dead or dying twigs have been easily attributable to winter-killing, brown-rot blight, and definite cankers at some point below.

SUMMARY STATEMENT

1. A heightened interest in peach growing has led to the adoption of the usually recommended practices of pruning, fertilizing, cultivating, and spraying.

2. Certain abuses have accompanied the adoption of these valuable practices: (a) in pruning, carelessness in making and treating the cuts has resulted in a long stub, and open wound thru which a fungus, such as the brown-rot organism, *Sclerotinia cinerea*, may enter and cause canker; (b) in some cases, excessive cultivation and fertilization evidently have contributed toward the heavy winter injury prevalent in Ohio peach orchards; (c) injudicious use of lead arsenate has resulted in a great deal of injury not only to foliage but to the twigs—to what extent larger limbs have been so injured is problematical.

A PORTABLE SUMMER COLONY HOUSE FOR PULLETS

D. C. KENNARD

The value of pullets in the fall and the assurance of profitable winter egg production depends largely upon the summer range and housing conditions. Suitable housing facilities often determine whether a desirable range can be utilized or not. For lack of a movable house the pullets are often ranged where little green feed is available and on ground run over by older birds and, therefore, more or less contaminated by diseases and parasites. On the other hand, if ample inexpensive portable summer colony houses are available, the pullets can be put on a suitable range of blue grass, clover, or alfalfa away from the range of older birds and where the soil is free from contamination. Furthermore over-crowding the pullets during summer months often permanently injures them. These contentions are evident to the progressive poultryman. The real question is, how can the housing and range facilities be provided to best advantage with the least expense? It is, of course, assumed that the portable brooder houses will be utilized, but often their capacity is not sufficient for summer requirements.

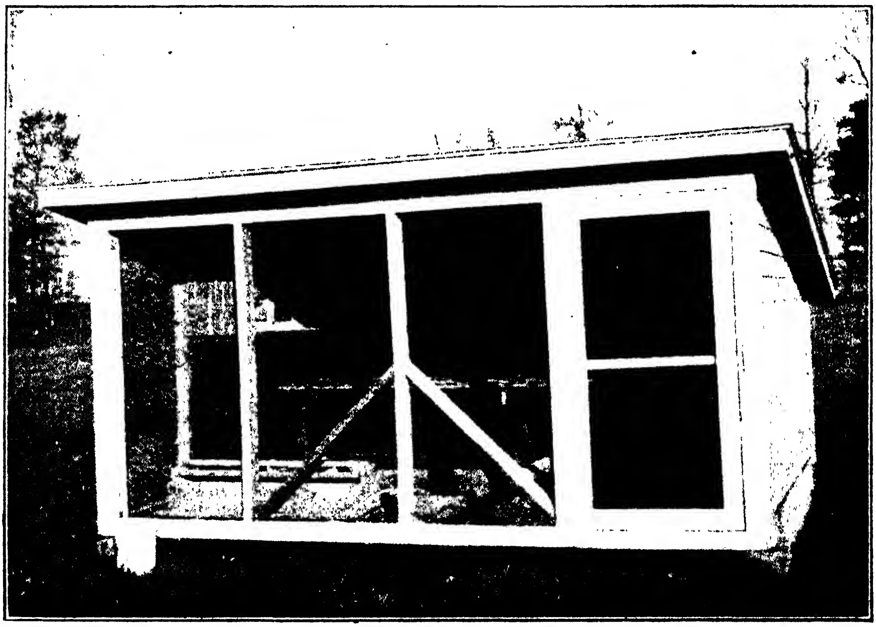
During the past two years gratifying results along this line were secured in connection with the poultry work at the Ohio Experiment Station. A summer colony house suitable for pullets on range was designed. This house can be built at about half the cost of the usual brooder house of the same size. With these houses located where suitable range and shade are available, the pullets, which no longer need artificial heat, can be developed with surprising economy of labor and feed cost, and with practically no mortality and, owing to uniform growth, but few culls. A good range simplifies the feeding problem so all that is required is water to drink and a simple, economical mash*, kept before the pullets at all times. As the all-mash method of feeding is employed, little time or attention is required for feeding.

What makes a suitable summer range?—The range for pullets must provide abundance of green forage, such as blue grass, clover, or alfalfa. In most cases this insures a clean soil, free from disease and parasites, especially when the range is utilized exclusively for the pullets. Shade is also essential for their comfort during hot

*Ground corn 70, winter wheat middlings 20, meat scraps 5, poultry bone meal (chick size) 4, salt 1. Further details as to summer feeding of pullets will be sent upon request.

weather. This can be supplied by trees and shrubbery. If trees suitable for roosting are near, the housing for Leghorns can be reduced one-half. The heavier breeds can not be expected to roost in the trees to any great extent.

The housing requirements.—If the pullets are to develop as desired, they must have ample room in the house at night as well as on the range. If trees suitable for roosting purposes are near, a 10 by 12 foot colony house may serve 200 to 300 pullets, provided additional dry mash feeders are located outside and protected from rain. Only 200 pullets should be put in such a house at the beginning, but when they start to roosting in the trees, more pullets may be added. If no trees are available for roosting and the pullets are obliged to roost inside, a 10 by 12 foot colony house will not properly accommodate more than 100 Leghorn pullets or 75 of the heavier breeds.

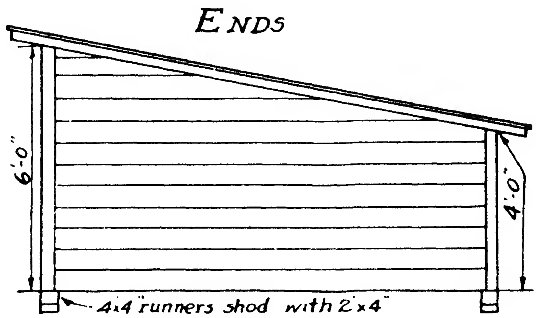


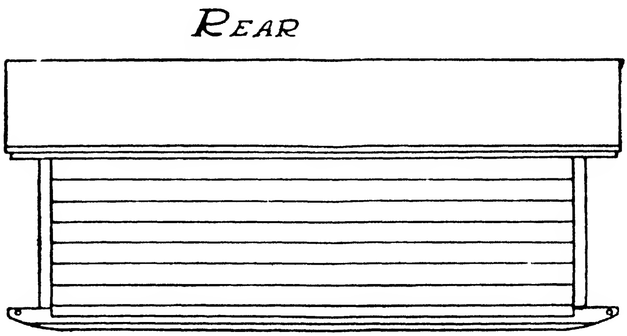
Portable colony house for the summer range. This house is 10 by 12 feet· with front entirely open and with neither floor nor windows, its cost is much less than that of a brooded house

The 4-foot reel mash feeders are used after the pullets are put on the summer range. One feeder should be provided each 75 or 100 pullets. The mash boxes are placed 2 inches off the ground or on the floor of the coop with a board 4 inches wide supported 3 inches below top edge of mash box on each side for the birds to stand upon.

The summer colony house.—Such a house needs no floor or windows. A 10 by 12 foot house with shed roof, 4 feet high in rear and 6 feet high in front, containing entrance door, and front covered with 1 or 2 inch mesh wire netting may usually be built for a material cost of about $30. The house is supported 10 to 12 inches off the ground. This provides the pullets a quick refuge from a sudden storm, and allows a free movement of air that not only makes it cooler but removes the moisture from the droppings so they need not often be removed. When it is desired to shut in the pullets at night or for any purpose, the open space below the house can be closed with boards or wire netting.

A general idea of the plan of construction is evident from the photograph. Further details are given in the plans. Six or eight 2 by 2 inch roosts about 11 feet 9 inches long are supported at ends and in the middle 2 feet above the lower sills. As the roosts occupy only 4 to 6 feet of the rear portion, ample room in front remains for two 4-foot reel mash feeders, and other equipment. The spaces at rear between rafters are left open. Siding or any matched lumber can be used for the rear and ends. Two 4 x 4 inch pieces, 14 feet long, serve for the sills and the runners under the front and rear sides. The runners are shod with 2 by 4 inch pieces on under side. The sills are securely braced by a 2 by 4 inch piece about 3 feet long in each corner. This is very necessary since there is no floor. The front is likewise braced from sill to end studs since there is no siding. The bracing in photo of front is different from that shown in plans, the latter being preferable as it is more secure and entrance door next to center stud avoids the corner sill brace which is inconvenient to step over. Five studs, approximately 2 feet 9 inches apart, serve the front and rear, and the 2 by 4 inch rafters are placed at the same distance and directly over each stud. Two studs serve each end, the distance between being about 3 feet.

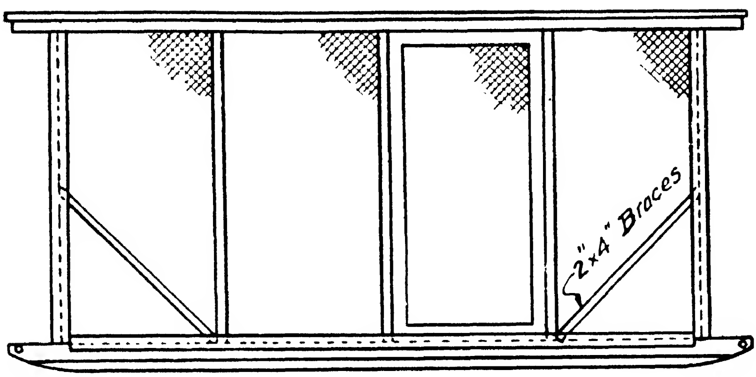


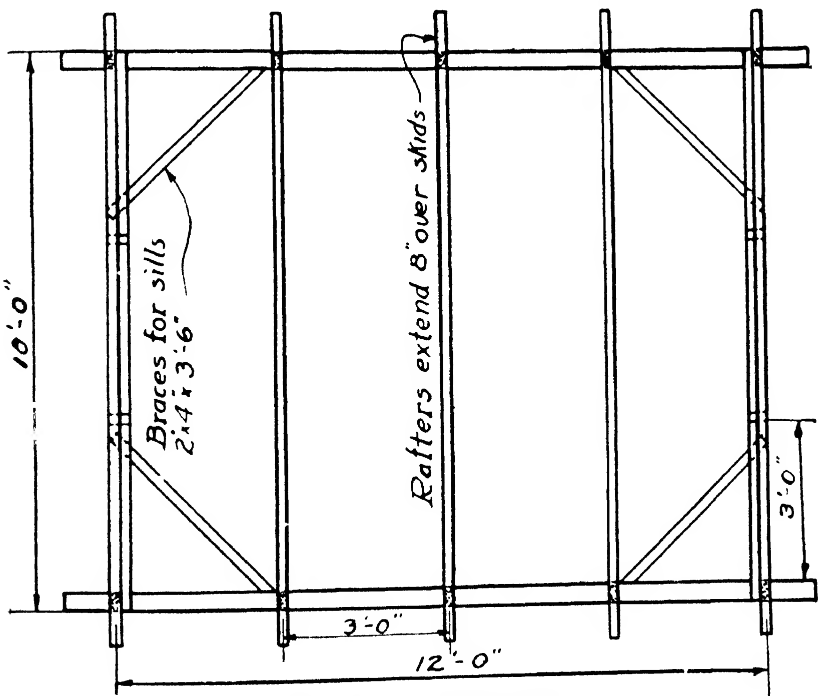


BILL OF MATERIAL FOR SUMMER COLONY HOUSE

2 pieces 2 x 4", 10 feet long—end sills
2 pieces 4 x 4", 14 feet long—front and rear sills and runners
2 pieces 2 x 4", 14 feet long—shoes for runners
2 pieces 2 x 4", 12 feet long—front and rear plates
5 pieces 2 x 4", 12 feet long—rafters
5 pieces 2 x 4", 6 feet long—front studs
5 pieces 2 x 4", 4 feet long—rear studs
1 pieces 2 x 4", 10 feet long—end studs
1 pieces 2 x 4", 12 feet long—end studs
2 pieces 2 x 4", 10 feet long—corner sill and front stud braces
150 square feet of drop siding
200 feet B M 1 x 8" ship-lap roof sheating
150 lineal feet 1 x 3"—corners and trimming
2 rolls prepared roofing
12 feet of 1 or 2 inch poultry netting, 6 feet wide
1 pr. 3-inch T hinges
1—3-inch door hasp
8 lb. 6d nails
4 lb. 8d nails
3 lb. 10d nails
2 lb. 20d nails

FRONT





Rafters-Plates and Sills

THE IMPROVED SEMI-MONITOR POULTRY HOUSE

D. C. KENNARD

Rapid progress has been made in the construction of improved types of poultry houses during recent years. Some years ago the popular idea was to glass-in most of the front and even slant the top away from the sun to get greater effect from heat of sun. Such a house proved unsatisfactory because it was too hot when the sun shines and too cold at night. A later type of sunlight house was the semi-monitor, which likewise proved hot in summer and cold in winter. A further objection to the semi-monitor house is that it is difficult to ventilate properly.

The semi-monitor was popular twelve to fifteen years ago and many were constructed in Ohio and a few are still being built. They are expensive and difficult to remodel in the usual way. At the same time, they are usually too good to tear down and rebuild because of the heavy loss of material. The question arises, therefore, is there any simple inexpensive way these houses can be modified to make them more satisfactory? This was a pertinent question in connection with the Station's poultry work since it has four of these houses with a total capacity of 1200 layers. The houses at the Station, like the majority of the others in the State, were built before the advent of the present types of houses, and when they were considered the last word in poultry housing.

In the improvement of the semi-monitor house, a simple procedure—"remove the cause"—proved effective. In other words, it is the semi-monitor type of roof that seems to cause the trouble and to "remove the cause" a straw loft was put in as shown in Figure 1.

How to put in the straw loft.—A 1 by 4 inch board is placed edgewise directly below every other rafter at a height of 6½ or 7 feet to give ample head room for the attendant. The ends of the supports are beveled so as to fit properly on the top of the rear plate and the front purlin. The supports are tied in the middle to the rafter directly above with 1 by 4 inch pieces. After this, 1 by 4 inch boards spaced 4 inches apart are nailed to the lower edge of the cross supports to retain the straw. It is well to start at rear and after nailing a few boards in place put in straw and repeat this until the loft is complete. The same procedure is followed when the boards are nailed to under side of the rafters and the straw is

packed between the rafters of the front portion. The straw over the loft should be only 8 or 10 inches thick so as to permit air to filter thru it.

It is well to nail the 1 by 4 boards to the cross supports with 6-penny box nails so that any of the boards can be easily removed when it is desired to remove and renew the straw. It is usually well to put in fresh straw each year in September or October, or just before the pullets are brought into laying house. Wire netting instead of boards may be used to retain the straw.

This arrangement of straw loft may also be used to advantage in shed-roof houses which have a high front. The straw can be placed between rafters from rear to where the lower edge of rafters is 7 feet above floor. From this point to the front the 1 by 4 supports may be put in place to support the straw loft ceiling 7 feet from the floor in the front portion of the house. With this arrangement the open space under the overhanging projection can always be left open. This will improve the means of ventilating, and make the house much warmer in the winter and cooler in the summer. In this way the high-front shed-roof houses can be made as satisfactory as the more recent houses with lower fronts.

The straw loft in the semi-monitor house excludes the light from the upper windows. To supplement light from another source it is necessary to put windows in the rear side below the droppings boards. This requires six-light sash with 10 by 12-inch glass, three feet apart. In some cases the upper windows in the semi-monitor house can be used for this purpose as they will be of little use after the straw loft is in place.

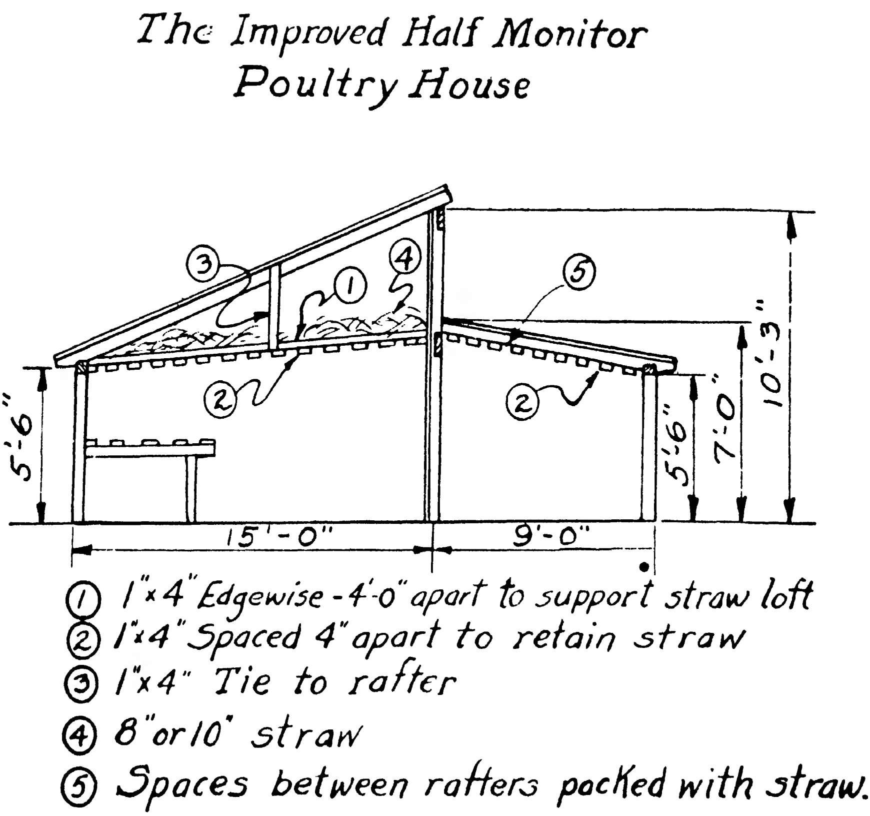


Fig. 1.—Showing straw loft in half-monitor house

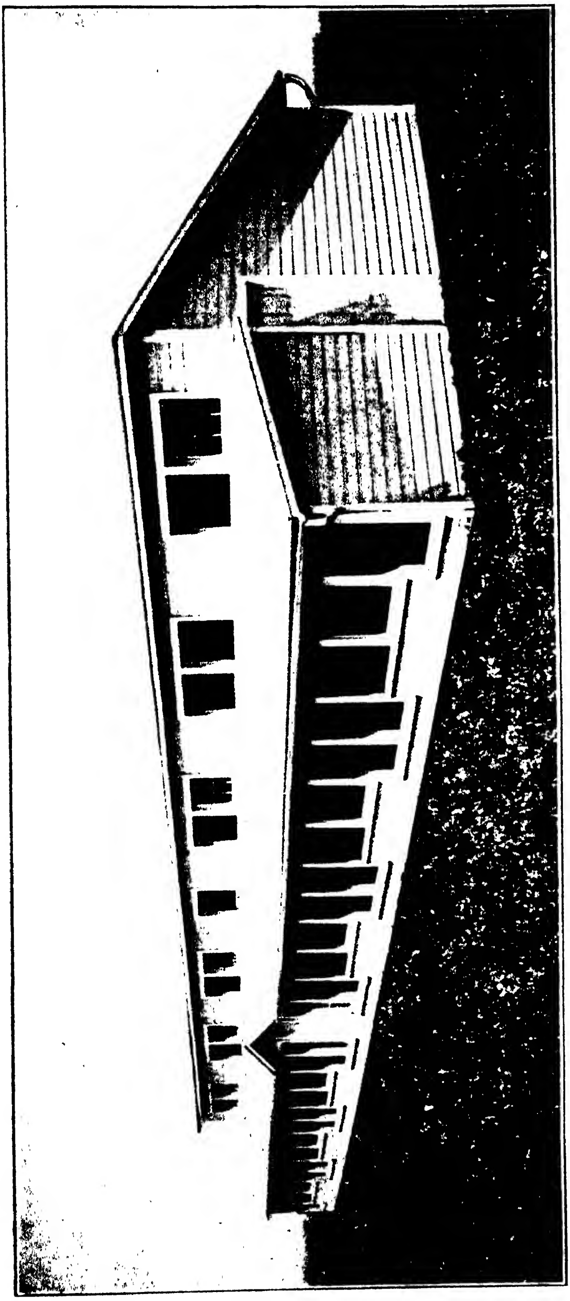


Fig. 2.—A typical semi-monitor laying house which is difficult to ventilate properly and is cold in winter. It is greatly improved by the straw loft

FARM PRODUCTS CONSUMED BY THE FARM FAMILY

J. I. FALCONER

Statements relating to the incomes of farmers often look surprisingly low. One frequently wonders while considering these figures in comparison with other incomes how it is that a farmer in spite of this apparently low cash income can still live well, raise his family, and buy a farm. One reason which makes this possible is the fact that many of the necessary expenses of the city or town resident are not required of the farmer. Another is that many of the things which the town or city resident must buy are furnished by the farm. To obtain information as to the value of products furnished by the farm to the family living, the Department of Rural Economics in 1923 obtained the value of these products on thirty-eight farms in Scioto County which were keeping farm accounts. The Data show the quantity of each product furnished by the farm to the household (averaging 4.3 adults each) with values figured in two ways: first, their sale value at the farm; second, their cost if bought in the nearby city of Portsmouth. The results are tabulated below.

Farm Produce Consumed by the Farm Family in Scioto County, Ohio, in 1923

Items used on farm	Quantity consumed	Country value	City value
Whole milk, quarts	872	$61.04	$113.36
Skimmilk, quarts	246	2.46	12.30
Cream, quarts	63	25.20	63.00
Butter, pounds	127	50.80	63.00
Eggs, dozens	172	51.60	77.40
Poultry, pounds	122	28.06	36.60
Pork, pounds dressed weight	476	61.88	119.00
Beef and veal, pounds dressed weight	48	4.80	10.56
Potatoes, bushels	26	26.00	31.20
Sweet potatoes, bushels	4	4.40	8.00
Cabbage, pounds	339	6.78	11.86
Sweet corn, dozens	59	7.08	14.75
Green beans, gallons	42	5.25	10.50
Tomatoes, bushels	10½	7.35	13.12
Other vegatables, as peas, carrots, cucumbers, lettuce, melons, etc, value		14.09	21.14
Apples, bushels	25	20.00	40.00
Pears, bushels	.6	.48	.90
Peaches, bushels	5	6.25	12.50
Cherries, gallons	10.4	4.16	12.48
Berries, quarts	6.6	8.25	16.50
Other fruits, such as currants, plums, gooseberries, grapes, value		3.50	5.25
Wheat ground for home use, bushels	6	6.00	6.60
Sorghum and honey, value		2.73	4.09
Firewood or coal, value		26.43	52.86
Rental value of house		144.00	447.00
Totals		$578.59	$1,203.97

INDEX NUMBERS OF CROP PRODUCTION IN OHIO

D. F. CHRISTY

The table gives the production index for Ohio crops. It follows the method used by Day in his index of physical production, and includes nine crops—corn, wheat, oats, barley, rye, buckwheat, potatoes, hay, and tobacco. Other indexes are being prepared for fruit and vegetables, livestock and livestock products. The average of the years 1909 to 1913 constitutes the basal period. Each crop is weighted in importance according to its total average annual value during the basal period. Such a system shows that corn, wheat, and hay make up 80 percent of our total crop value, and any big changes in these crops affect the index to a marked degree. The average production index by five-year periods is also shown.

The low index in 1924 was the result of a very poor corn crop that year; that of 1921 was due to a low production of wheat, oats, potatoes, and tobacco with only an average crop of corn and hay. Corn was also the main factor in the low figures noted in 1901, 1903, and 1904. Wheat aided in lowering the figures for 1912, wheat and corn those for 1916, and wheat and hay those for 1900.

INDEX NUMBERS OF CROP PRODUCTION IN OHIO
Average 1909-1913=100

Year and period	Production index	Year and period	Production index	Year and period	Production index
1881	59	1901	73	1921	91
1882	67	1902	91	1922	100
1883	63	1903	73	1923	103
1884	68	1904	76	1924	90
1885	70	1905	84	1925	102
1886	75	1906	99	....	....
1887	61	1607	73	....	....
1888	69	1908	94	....	....
1889	78	1909	105	....	....
1890	60	1910	107	....	....
1891	78	1911	93	Five-year average	
1892	67	1912	97	1881-85	65
1893	61	1913	98	1886-90	69
1894	67	1914	95	1891-95	65
1895	54	1915	109	1896-00	66
1896	69	1916	86	1901-05	79
1897	66	1917	112	1906-10	96
1898	70	1918	105	1911-15	98
1899	70	1919	110	1916-20	104
1900	55	1920	108	1921-25	97

COST OF LIVING IN FARM HOMES OF DELAWARE COUNTY, OHIO

C. E. LIVELY

Information relative to the cost of family living on the farm in 1923 was collected by the Division of Farm Population and Rural Life of the Bureau of Agricultural Economics, U. S. Department of Agriculture and the Department of Sociology, Ohio Wesleyan University cooperating. The families, 383 in all, were contiguous to the city of Delaware in the central part of the county. Only farm homes having an adult male farm operator and adult female homemaker were studied.

The average size of family was found to be 4.1 persons, which is about the average for the farm family of Ohio. Others, such as relatives and hired help, increased the size of the household to 4.3 persons.

Average Expenditures per Family for 383 Delaware County Farmers for the Year Ending Oct. 1, 1923 by Tenure Groups, and Values Purchased and Furnished by the Farm

Item	Total (383)			Owners (283)			Tenants (84)			Hired men (16)		
	Furnished	Purchased	Total	Furnished	Purchased	Total	Furnished	Purchased	Total	Furnished	Purchased	Total
Food	$346	$224	$570	$354	$223	$577	$337	$227	$564	$251	$227	$478
Clothing	......	238	238	......	241	241	......	239	239	.....	165	165
Rent	255	......	255	272	......	272	214	...	214	172	.....	172
Furnishings	......	50	50	......	47	47	......	53	53	.....	79	79
Operating expense	39	182	221	37	194	231	42	157	198	56	117	174
Health	......	56	56	......	57	57	.....	47	47	......	81	81
Advancement	......	76	76	......	86	86	.....	49	49	......	32	32
Personal	.....	48	48	......	47	47	......	52	52	......	37	37
Life and health insurance	......	27	27	......	27	27	......	27	27	......	26	26
Unclassified	......	2	2	.....	2	2	......	2	2	......	......	......
Totals	640	901	1541	663	923	1586	592	852	1444	479	765	1243

Even dollars only are reported in this table. Rent is charged as 10 percent of the value of the house. Food amounted to 37 percent of the total expenditure, clothing 15.4 percent, rent 16.6 percent, furniture and furnishings 3.2 percent, operating expense 14.4 percent, health 3.6 percent, and advancement 4.9 percent. These varied with the tenure groups. Of the total costs 41.5 percent was contributed directly from the farm in the form of food, rent, and operating expense.

The Bimonthly Bulletin

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Ohio Agricultural Experiment Station

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Wooster, Ohio, U. S. A.

A poi ion o e Station's Pou y Plan

BIMONTHLY BULLETIN

OF THE

Ohio Agricultural Experiment Station

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GROWTH OF CHICKS AS AFFECTED BY SUNLIGHT THRU WINDOW GLASS, THRU A GLASS SUBSTITUTE, AND DIRECT SUNLIGHT

R. M. BETHKE AND D. C. KENNARD

Within the last few years extensive investigations have been conducted with chicks to determine their nutritional requirements. All these numerous tests show that to safeguard against leg weakness, some material like cod-liver oil or egg yolk, rich in the anti-rachitic vitamin, or its equivalent, direct sunlight, must be supplied to insure success.

Cod-liver oil has been extensively employed with good results. Its use, nevertheless, has some drawbacks in that not all grades of this oil possess the same potency. Thus the poultry keeper has no direct assurance of procuring a highly efficient oil unless he obtains a product which has been tested for its anti-rachitic properties, for which he usually pays a premium.

Many poultry men have also inquired into the possibilities of using artificial sunlight as produced by the quartz mercury vapor lamp, or carbon arc lamp. Here again he is confronted with certain difficulties which virtually make the question of artificial sunlight impractical. Altho he is probably aware of the beneficial effects of direct sunlight, he is at a loss to make use of this natural remedy at all times on account of the weather. He also has been instructed that window glass as ordinarily found in our homes and poultry houses filters out the effective rays of the sun. What, then, can he do to obtain the benefits of direct sunlight? Is there a possible substitute for ordinary glass? How about some of these glass substitutes that are on the market?

In order to answer the foregoing questions, with which we were confronted daily, an experiment was started to determine what the facts are.

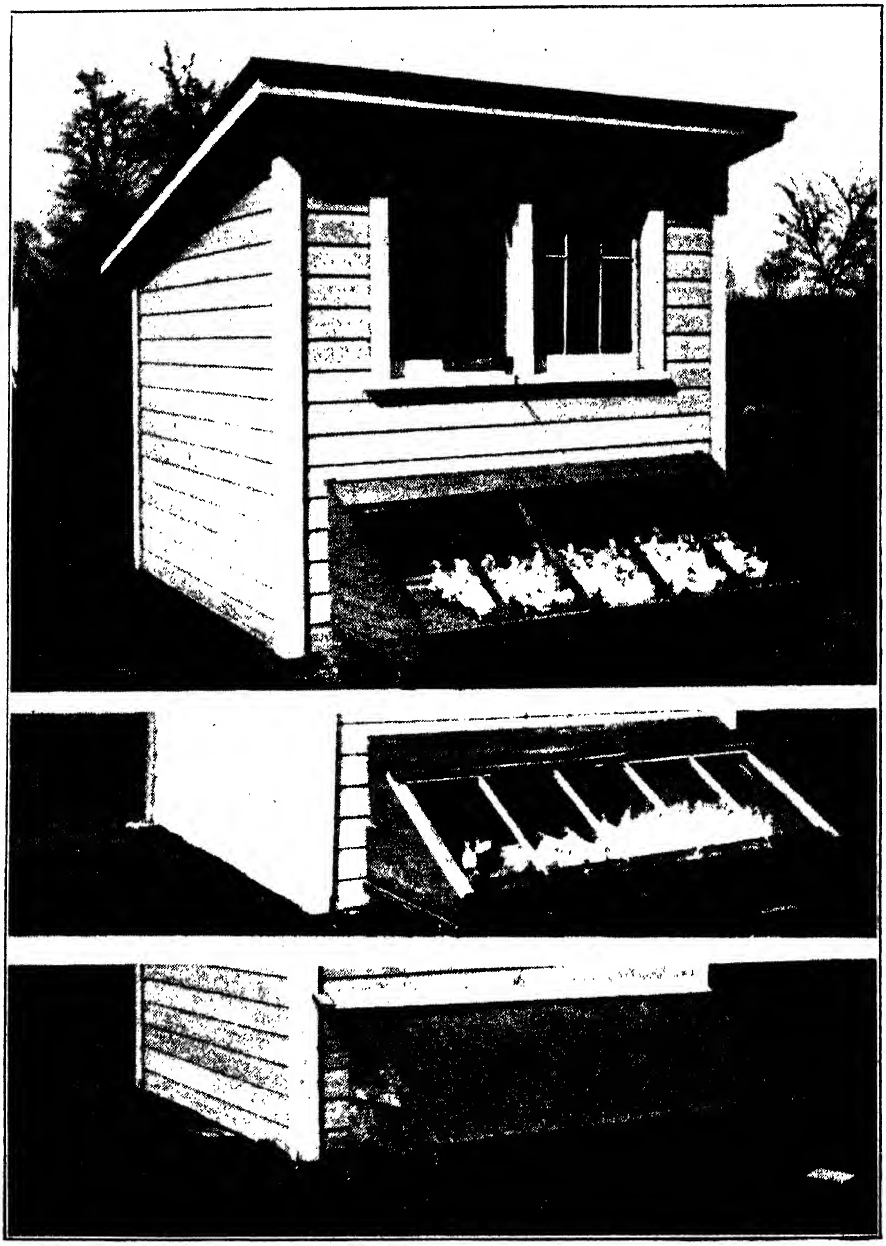


Fig. 1.—The three sun parlors covered with 1-inch mesh wire netting, window glass, and "celo-glass" in the order shown above

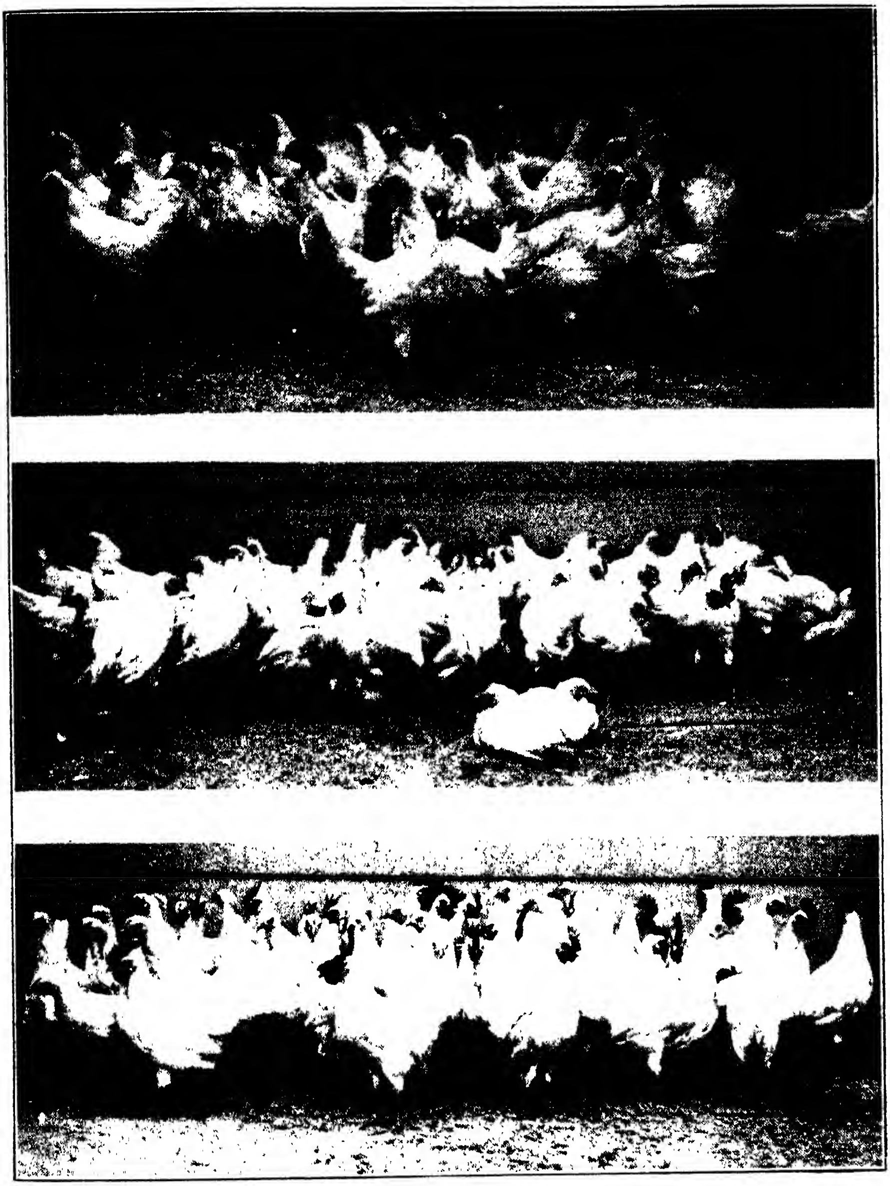


Fig. 2.—The first group of chicks above received direct sunlight and were apparently normal.

The second group received sunlight thru window glass. All had leg weakness at seven weeks when photographed.

The third group received sunlight thru "celo-glass", which enabled the chicks to make practically the same growth as those receiving direct sunlight.

On March 18, 1926, 300 week-old White Leghorn chicks, hatched from the Station's flocks, were divided into three lots of 100 each and placed in separate colony houses of 8 by 8 feet, with gas brooder stoves. In addition, each house was provided with a "sun parlor" 3 by 7 feet on the south side, which the chicks had access to during the day. The top of one "parlor" was covered with window glass, the second with one-inch poultry netting, and the third with "celo-glass" (See page 132).

TABLE 1.—Weight and Mortality of the Three Different "Light" Groups

Age	Open parlor		Window glass parlor		"Celo-glass" parlor	
	Number surviving	Total weight of survivors	Number surviving	Total weight of survivors	Number surviving	Total weight of survivors
Wk.	*No.*	*Lb.*	*No.*	*Lb.*	*No.*	*Lb.*
1	100	12.2	100	12.9	100	12.6
3	100	26.1	99	26.6	98*	24.8
5	100	52.6	99†	46.2	96	50.1
7	100	91.0	96‡	61.5	96	84.5
9	99	139.1	....	....	96	128.8
10	99	149.7	....	....	96	140.4

*Two chicks accidentally killed.
†Approximately one-third of the group showed signs of leg weakness.
‡The "window-glass" group was discontinued after the eighth week when all chicks of the group showed severe signs of leg weakness.

The chicks were all kept at the same relative temperature and subjected to the same routine management. All three groups alike received a ground mash composed of yellow corn 70, wheat middlings 22, meat scraps 5, raw bone meal 2, common salt 1, and skimmilk ad libitum.

The chicks in all the groups grew at a normal rate to the fifth week when approximately one-third of those in the "window-glass" group showed signs of failure, attendant with a slower gain in weight. (See Table 1). By the eighth week all the chicks in this lot, which was then discontinued, exhibited severe signs of leg weakness. The two other groups continued to make normal growth to the close of the experiment, or the 10th week, with no evidence of nutritional failure. No outstanding or apparent difference was noted between the group that had access to direct sunlight and the one which received sunlight filtered thru "celo-glass". The chicks of both groups made excellent gains reaching a weight of approximately 1.4 to 1.5 pounds per chick at 10 weeks of age.

Whether the chicks under "celo-glass" received all the beneficial effects of direct sunlight, we are unable to state. However, from the data presented it would appear that enough of the effective ultra-violet rays were transmitted by the "celo-glass" to offer protection against leg weakness for a period of 10 weeks or longer.

Further evidence is presented to show that window glass is ineffective in the transmission of the beneficial ultra-violet rays. This, in part, offers an explanation for soft shelled eggs, egg paralysis, and decreased egg production which result when laying flocks are deprived of the vital rays of the sun and no provision is made in the ration to supply this deficiency.

The possible practical application of this or equally efficient glass substitutes are self-evident. It not only offers possibilities for protecting the chicks from unfavorable weather but also at the same time obtains some of the beneficial effects of direct sunlight. Altho we have no direct evidence that similar beneficial results could be secured with laying flocks, we have reason to suppose that some improvement over window glass would result.

LEGUME HAYS INSTEAD OF GREEN FEED FOR CHICKENS

D. C. KENNARD AND L. B. NETTLETON

Green feed or its equivalent is one of the most vital parts of the ration for chickens and it is that part of the diet which many poultry keepers find the greatest difficulty in providing. It is believed that without green feed or its equivalent no ration can prove successful. It seems that more poultry keepers fail to meet this than any other feeding requirement. In summer the best solution of the green feed problem is a good range. During the late summer and fall when the range becomes depleted, a generous supply of early cabbage or swiss chard is probably best. But the big problem is during the winter months.

The winter supply of green feed is usually limited and it is difficult to store. In various feeding trials conducted by the Station to learn whether there are any satisfactory substitutes or equivalents for green feed, surprisingly favorable results were obtained from the use of legume hays. While, no direct comparisons were made with succulent green feed and the legume hays, yet the results were equal, if not superior, to what we would expect according to our previous experience in feeding greens in the succulent form. The first year's test with alfalfa gave the highest winter egg production of the rations enumerated. Soybean hay gave surprisingly good results. It was also fed to 220 other pullets and they laid especially well and the mortality was low.

It would seem from these results that high quality, green, leafy alfalfa, red clover, or soybean hay may be effectively substituted for succulent green feed, especially during the fall and winter months.

How hay is fed to chickens.—A satisfactory way is to cut the hay in ½-inch lengths by passing it thru a cutter. The cut hay can then be put into a wire netting basket feeder, and kept before the birds all the time. Or the hay without cutting can be fed in suitable wall racks with the front inclosed by lath or wire netting. Still another method is to tie a bundle of the hay with a small rope and suspend it from the ceiling so the center of the bundle is about ten inches above the floor.

Kinds and quality of hays.—Alfalfa, red clover, and soybean hay are satisfactory. Results thus far secured indicate these hays to be about equally valuable. Regardless of the kind of hay, it is necessary that it be made from the immature plant so as to carry a large proportion of leafy material. It is the leafy portion that carries the valuable constituents for chickens. The hay should be of high quality, which means that it must be carefully cured without getting wet, so that it will have as green a color as possible. Sometimes it may be necessary to cure the hay inside, altho suncured hay is regarded as being superior in some respects to that cured without exposure to direct sunlight. Usually the second or third cuttings of clover and alfalfa are best. Soybean hay should be cut when the seeds are just beginning to form in the pods. At this stage a large proportion of the hay is leafy, palatable, and of a high protein content.*

In various feeding trials at this Station during the last three years, alfalfa hay gave uniformly good results. Needless to say it is easier to provide a uniform, dependable supply of legume hay for the winter season than succulent green feed, and furthermore, the hay involves much less labor of feeding.

*Details as to time of cutting soybean hay are given in Bulletin 384 of the Ohio Experiment Station.

SOYBEANS AND SOYBEAN OILMEAL FOR MILK PRODUCTION

C. C. HAYDEN AND A. E. PERKINS

The growing of soybeans has increased greatly in Ohio during recent years; and the question of their use as a source of protein in dairy rations has been repeatedly raised. Considering their protein content, they should be about equal to linseed oilmeal or cottonseed oilmeal. In order to get more direct information on this subject two tests were made; one comparing ground soybeans with linseed oilmeal, and the other soybean oilmeal with linseed oilmeal.

GROUND SOYBEANS

The cows.—Eight cows were used in comparing ground soybeans and linseed oilmeal, two Holsteins and two Jerseys in each of two lots. The lots were as evenly divided as seemed possible, all factors considered. The cows in the two lots were treated alike except in the protein supplement fed. The double reversal system of feeding was used. The cows were weighed at the beginning, at the end of each month, at the exchange of rations, and at the close of the experiment.

The rations.—The roughage fed to both lots was corn silage and mixed and clover hay. The grain mixture consisted of equal parts by weight of corn, oats, and ground soybeans in one ration and corn, oats, and linseed oilmeal in the other. These rations were fed in the proportion of three pounds of silage, one pound of hay, and one pound of grain. The cows were given all they would clean up readily. The average daily amounts consumed were about 29.2 pounds of corn silage, 8.8 pounds of hay, and 9.8 pounds of grain carrying about 3¼ pounds of either ground soybeans or linseed oilmeal. Some hay was refused.

The feeding began January 9, 1924; the rations were exchanged March 16; and the experiment closed May 31, 1924.

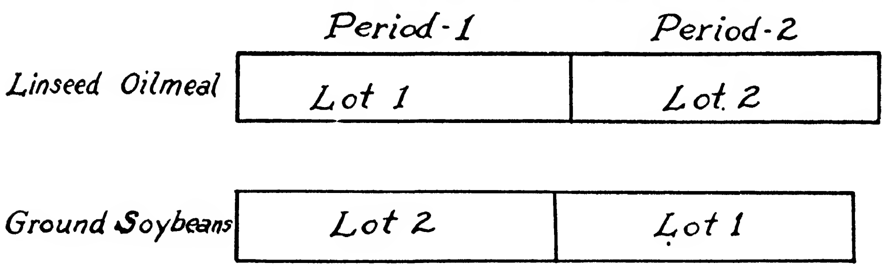
RESULTS

In summing up the results, the data collected during the first two weeks and the two weeks following the exchange of rations were discarded to avoid the carry-over effects of the previous ration. Table 1 shows the amounts of milk and butterfat produced

and the feeds consumed during the two seven-week periods selected for comparison. Graph 1 shows the relative volume of milk produced by each lot on each ration and the total on both rations.

TABLE 1.—Milk and Fat Produced and Feeds Consumed First Period 3d to 9th Weeks, Inclusive; Second Period 12th to 18th Weeks, Inclusive

	Period	Lot	Milk	Fat	Grain	Silage	Hay	Grain in weight per cow
			Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Linseed oilmeal	1	1	4,325.8	196.4	1,968.5	5,864.5	1,863.0	15
	2	2	4,059.3	174.5	1,882.0	5,621.5	1,627.5	20
Total	....	......	8,385.1	370.9	3,850.5	11,486.0	3,490.5	35
Ground soybeans	1	2	4,119.8	172.6	1,907.0	5,703.5	1,770.5	23
	2	1	3,947.4	188.3	1,950.0	5,828.5	1,692.0	15
Total	....	......	8,067.2	360.9	3,857.0	11,532.0	3,462.5	38
Difference in favor of oilmeal			317.9	10.0	−7.0	−46.0	28.0	−3
Difference in favor of oilmeal, percent			3.6	2.7	....	....	....	....



Graph 1.—Relative amounts of milk produced on each ration

In the 14 weeks of the test 318 pounds, or 3.6 percent less milk, and 10 pounds, or 2.7 percent less fat, were produced from the soybean ration than from the linseed oilmeal ration. The amounts of feeds consumed from the two rations were nearly equal. The cows with one exception were young and growing and all gained in weight The average gains were about equal as shown in Table 1.

CONCLUSION

In this single trial linseed oilmeal was somewhat superior to ground soybeans when fed in equal amounts. This does not fully agree with the findings at some other stations. The effect of the soybeans on the quality of the butterfat was not determined in this test.

Other experiments.—McCandlish, Weaver, and Lund, working at the Iowa Station, (Iowa Bul. 204) in two tests of 30 days each, found that cracked soybeans reduced the amount of milk, but increased the amount of fat quite materially. Olson, working at the South Dakota Station (S. D. Bul. 215), in two tests of 40 days each, found a 2.3 percent increase of milk and no increase of fat, and 7.52 percent increase of milk and 3.25 percent increase of fat in favor of ground soybeans. In his tests soybeans to the extent of the full grain ration did not seriously affect the quality of the fat. Fairchild and Wilbur, working at the Indiana Station (Purdue Bul. 289), in two 28-day tests obtained better results in each case with soybeans. They also fed a mineral supplement with soybeans to one lot of cows, but without beneficial effects, which is contrary to results obtained by others with hogs. Otis, working at the Kansas Station (Kan. Sta. Bul. 125), found that ground soybeans fed to the extent of one-half the grain mixture caused the butter to be too soft to work well.

From these and our results we may conclude that ground soybeans are equal to linseed oilmeal in the ordinary dairy ration; and that, if the cream is to be used for butter making, it may be well not to use them in excess because of their possible softening of the butterfat.

SOYBEAN OILMEAL

This experiment comparing soybean oilmeal and linseed oilmeal was conducted in the same manner as the one comparing ground soybeans and linseed oilmeal.

The cows.—Six Holstein cows in two lots of three each were used, and fed according to the double reversal system.

The rations.—The roughages fed to both lots were corn silage and mixed and clover hay. The grain mixture consisted of equal parts by weight of corn, oats, and soybean oilmeal in one case; and corn, oats, and linseed oilmeal in the other. In these rations the cows were made to depend largely on the oilmeals for protein, which should have brought out any difference in the value of the two oilmeals. The feeding began December 12, 1924; the rations were exchanged March 1; and the experiment closed May 15, 1925.

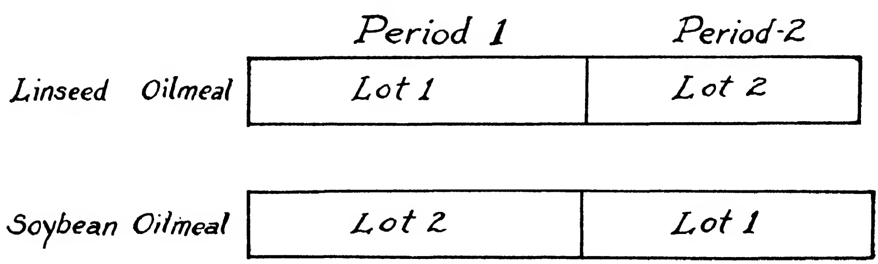
RESULTS

Table 2 gives the milk and fat produced and feeds consumed by each lot on each ration during the periods compared. The data for two weeks at the beginning and two weeks after the exchange of rations were discarded to avoid the effects of the previous ration.

The table shows that 1.9 percent more milk and 3.6 percent more butterfat were produced by the soybean oilmeal ration, the difference in fat being about twice the difference in milk. Less than 2 percent difference in milk may fall within the limits of probable error, and therefore is not significant, unless confirmed by a considerable number of tests. The cows gained in weight an average of nine pounds more each while on the linseed oilmeal ration. Examinations of the butterfat from the individual cows showed considerable variation. Averaging the results, the soybean oilmeal seemed to have no effect on the hardness of the butterfat. The butterfat from the cows fed the soybean oilmeal showed slightly *more* of the volatile fatty acids.

TABLE 2.—Milk and Fat Produced and Feeds Consumed on Linseed Oilmeal Vs. Soybean Oilmeal Test First Period 3d to 11th Weeks, Inclusive; Second Period 14th to 22d Weeks, Inclusive

	Period	Lot	Milk	Fat	Grain	Silage	Hay	Grain in weight per cow
			Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Linseed oilmeal	1	1	7,194.8	239.2	2,560.2	7,675.4	2,486.2	23
	2	2	5,854.7	223.5	2,322.2	6,970.9	2,288.3	19
Total			13,049.5	462.7	4,882.4	14,646.3	4,774.5	42
Soybean oilmeal	1	1	7,014.6	250.6	2,497.7	7,461.6	2,460.7	31
	2	2	6,283.3	229.0	2,358.5	7,090.0	2,319.1	2
Total			13,297.9	479.6	4,856.2	14,551.6	4,779.8	33
Difference in favor of soybean oilmeal			248.4	16.9	26.2	94.7	—5.3	9
Difference in favor of soybean oilmeal, pct			1.9	3.6				



Graph 2.—Relative amounts of milk produced on each ration

This test indicates that soybean oilmeal is superior to linseed oilmeal; but one test is not sufficient to warrant a final conclusion.

Other experiments.—Lindsey, Hall, and Smith, working at the Massachusetts Station (Mass. Station Report 1907-8), found that

soybean oilmeal had no unfavorable effect on the milk or the butterfat. Fairchild and Wilbur (Purdue Bul. 289) conducted three tests of 28 days each and concluded that soybean oilmeal and linseed oilmeal are practically equal. A mineral supplement fed with soybeans had a negative or slightly unfavorable effect.

GENERAL CONCLUSIONS

From the results of the two tests here reported and from results at other stations we may draw the following conclusions:

1—Ground soybeans are equal or slightly superior to linseed oilmeal, when fed in ordinary rations to dairy cows. This superiority seems to be due to their higher oil content, rather than their protein content.

2—Soybean oilmeal and linseed oilmeal appear to be equal.

3—In our experiments there was a hint that the protein of the linseed oilmeal may be superior to that of the soybeans, altho all rations carried enough protein to mask moderate differences in quality.

4—Soybeans and soybean oilmeal tend to cause a higher percentage of butterfat in the milk, which probably is temporary.

5—No unfavorable effect on the animals due to the soybeans or soybean oilmeal has been noted. In some cases, the ground soybeans caused a softer butterfat.

6—Either soybeans or soybean oilmeal can properly replace linseed oilmeal in the ration when the prices are about equal.

POTATO DUSTING AND SPRAYING IN 1925

PAUL E. TILFORD

Since a large number of Ohio potato growers are interested in the effectiveness of copper-lime dust, and how it compares with liquid spray for the prevention of potato diseases, it seems worth while to report the potato dusting and spraying experiments of 1925. The application of a fungicide, whether dust or liquid, to potato vines in Ohio is primarily for the prevention of hopperburn. Early blight is usually present thruout the State, but is not often serious. Late blight occurs only in northern Ohio and seldom in epidemic form. Both early and late blight, as well as hopperburn, can be prevented by the thoro application of a proper copper fungicide.

Numerous tests have demonstrated the effectiveness of bordeaux mixture, when properly applied, as a fungicide for potato spraying. Both the upper and lower surface of the leaves must be covered with the spray. A sprayer to do the job properly and profitably must have three nozzles to a row and develop a pressure of 200 to 225 pounds. Old sprayers or hand sprayers will not do this. The small grower whose limited acreage does not warrant a high pressure sprayer practically is forced to let his potatoes go unsprayed. Naturally such growers have been attracted by dusting, since hand dusters are efficient and easy to operate. The convenience of application, due to the fact that no water is necessary, has also interested many large growers in dusting. The problem has been to find a dust as satisfactory as bordeaux mixture. With this problem in mind, the writer conducted dusting and spraying tests in Ohio during the last two seasons.

The results obtained in 1924 are given in the Monthly Bulletin of the Station for January-February, 1925. They can be briefly summarized by stating that four applications of 4-6-50 bordeaux mixture gave an increase of 105.8 bushels, and that four applications of copper-lime dust gave an increase of 43.4 bushels to the acre.

TABLE 1.—Potato Yields and Increases Due to Spraying and Dusting

Treatment	Date of treatment	Number of plots	Yield per acre	Increase over check
			Bu.	*Bu.*
Check, no treatment	....	7	205.9	....
4-6-50 bordeaux	1st – July 1 2d – July 14 3d – July 29 4th – August 19	6	265.9	60.0
5-7½-50 bordeaux	1st – July 1 2d – July 14 3d – July 29 4th – August 19	3	265.0	59.1
Copper-lime dust	1st – July 2 2d – July 15 3d – July 29 4th – August 20	6	278.1	72.2

In 1925 the plots were planted May 13 with Michigan certified Rural russet seed. Each plot contained 1/50 acre, but the yields given below are calculated to an acre basis. Each treatment was applied on at least three different plots and some were repeated six times. Every fourth plot was left untreated for a check. Hydrated lime was used in the preparation of the bordeaux mixture. The copper-lime dust used contained 36 percent of copper-sulphate

crystals. A poison was combined with both the liquid and the dust for the first two applications. The bordeaux was applied with a power sprayer which carried three nozzles to the row and developed the right amount of pressure. A fan type of hand duster which gave a continuous flow of dust was used.

The potatoes were dug October 2 and weighed. The results are given in Table 1.

After determining the total yield per acre the tubers were run over a grader set to remove all tubers smaller than 1⅞ inches in diameter. The average yields of firsts and culls calculated to bushels per acre, with the percent of culls, are given in Table 2.

TABLE 2.—Yield of Firsts and Culls from Sprayed and Dusted Potatoes

Treatment	Firsts	Culls	Culls
	Bu.	*Bu.*	*Pct.*
Check, no treatment	185.7	20.2	10.9
4-6-50 bordeaux	248.0	17.9	7.2
5-7½-50 bordeaux	246.1	18.9	7.7
Copper-lime dust	262.3	15.8	6.0

The treated plots thruout the season looked more vigorous and had a darker green color than the untreated plots. Some hopper-burn appeared in all plots, but the injury was slight and about the same in all treated plots, while the check plots were severely injured. No late blight was present and only a small amount of early blight which did not appreciably influence the yields in any of the plots.

The yields from all treated plots show substantial increases over the checks. Bordeaux mixture of 4-6-50 strength gave as great an increase as 5-7½-50. The dusted plots for some unexplainable reason outyielded the sprayed plots by 12 bushels to the acre. The season was very favorable for dusts in that there were not many heavy rains to wash the dust from the leaves, which perhaps accounts in part for the excellent results obtained.

A dusting experiment was conducted under the supervision of the Experiment Station on the farms of two commercial potato growers of Portage County during the season of 1925. The potatoes in each experiment were planted in the latter part of June. A home-mixed dust and a commercial ready-mixed dust were used. Each dust analyzed approximately 20 percent mono-dehydrated copper-sulphate. Four applications were made with a power duster. On one farm it was possible to compare the dust with liquid spray. The results obtained on this farm were as follows:

Check—no treatment, yield 215.7 bu. per acre.
Sprayed—bordeaux, yield 287.2 bu. per acre, gain 71.5 bu.
Dust—home mixed, yield 305.6 bu. per acre, gain 89.9 bu.
Dust—commercial mixed, yield 270.8 bu. per acre, gain 55.1 bu.

On the second farm no spraying was done, so the only comparison that could be made was that of the value of dust over no treatment. The results obtained in this test were as follows:

Check—no treatment, yield 152 bu. per acre.
Dust—home mixed, yield 200 bu. per acre, gain 48 bu.
Dust—commercial mixed, yield 181 bu. per acre, gain 29 bu.

In each test the dusts gave good increases, the home-mixed dust in each case being the best. The writer feels that too much emphasis should not be laid on a single season's results, showing that home-mixed dust produced a greater increase than ready-mixed dust. More tests must be made before satisfactory conclusions can be drawn. It seems safe, however, to conclude that the home-mixed preparation is as satisfactory as a commercial dust and it can be prepared much cheaper than the price of the commercial product.

In conclusion, it can be said that four applications of either bordeaux mixture or of copper-lime dust gave profitable increases in yield. The excellent results obtained from the use of dusts are encouraging; but 4-6-50 bordeaux mixture is still recommended for the commercial grower whose acreage warrants a high-pressure sprayer. More results as satisfactory as those reported above must be obtained before it can safely be said that dusts are as good as liquid spray. It is certain, however, that an increase in yield can be expected from the use of dust and its use is recommended for the small grower who must resort to hand machinery, since hand dusters are satisfactory while hand sprayers are not.

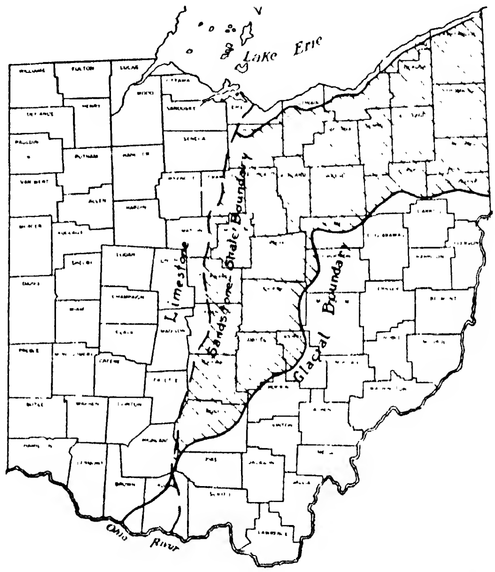
THE GLACIAL SANDSTONE AND SHALE SOILS OF OHIO

G. W. CONREY

The area of glacial sandstone and shale soils includes east central and northeastern Ohio. On the west it is bounded by the limestone area. The southern limit is the glacial border which extends from Columbiana County west to Holmes County, and thence southwest thru Chillicothe. Within this area all of northeastern Ohio is included with the exception of the narrow belt of "lake plain" bordering Lake Erie.

Origin of the soils.—The upland soils are of glacial origin, having been formed by the weathering of the mantle of glacial drift which covers the land surface. During the glacial period the ice did not advance as far to the south in eastern Ohio as it did in the central and western parts of the State, hence the belt of glacial soils in northeastern Ohio is much narrower than it is farther west.

The rocks of the region which contributed to the glacial drift are variable, being, however, chiefly sandstone and shale. Extending north and south across central Ohio, and for a number of miles back from Lake Erie in the northeastern counties is a belt of dark shale—the "Ohio shale." To the east and south is another belt known as the "Waverly sandstone and shale", which is variable as regards the character of the rock. An outstanding feature of the Waverly formation is the very fine grain of most of the sandstone. On weathering, this gives a silt loam rather than a coarser soil. Still further to the south and east are the "Coal Measures" rocks, which consist chiefly of sandstone and shale. In places the sandstone is coarser than the Waverly and weathers to a coarser soil.



Area of Glacial Sandstone and Shale Soils

These various rock formations have contributed to form the glacial drift of the region. Only a small part of the drift has been carried a great distance, that is from Canada. Local rock material makes up a large part of the glacial drift. Over the broad areas of shale the glacial material which forms the soils is a heavy clay. Where sandstone predominates, the soils are lighter in texture—loams or silt loams. Elsewhere a mixture of the two has given a glacial drift of intermediate texture.

Topography and drainage.—The surface of the land varies from the nearly level glacial plain to the rolling tracts along some of the main stream valleys and also adjacent to the unglaciated area to the south. With these various topographic conditions are

GLACIAL SANDSTONE AND SHALE SOILS

Color of soil	Brown	Light brown	Light brown	Grayish-brown	Brownish-gray	Brownish-gray	Light gray	Dark gray to grayish-black	Brown	Brownish-gray
Color and	Yellowish-brown	Pale yellowish-brown	Pale yellowish-brown	Pale yellowish-brown	Mottled gray and yellowish-brown	Mottled gray and yellowish-brown	Mottled gray, yellowish-brown and rust-brown	Mottled bluish-gray, gray and rust-brown	Yellowish-brown	Mottled gray, yellowish-gray, and yellowish-brown
character of subsoil	Only slightly heavier than surface soil	Mottled yellowish-brown and gray in lower subsoil Only slightly heavier than surface soil	Mottled yellowish-brown and gray from 16 to 24 inches and much heavier than surface soil Lower subsoil more friable	Mottled below 16 to 18 inches Lower subsoil brownish-drab clay	Only slightly heavier than surface soil	Lower subsoil heavy silty clay	Level to undulating		Bedrock (sandstone) at 12 to 36 inches	Very heavy Bedrock (shale) at 12 to 36 inches
Topography	Rolling	Gently rolling	Gently rolling	Gently rolling	Undulating	Undulating	Level to undulating	Level	Rolling to sloping	Undulating
Natural drainage	Good	Fair to good	Fair	Fair	Poor	Very poor	Very poor	Very poor	Good	Very poor
Series	**Wooster**	**Canfield**	**Rittman**	**Ellsworth**	**Volusia**	**Mahoning**	**Trumbull**	**Chippewa**	**Lordstown**	**Allis**
Important textures	Loam silt loam	Silt loam	Silt loam	Silt loam silty clay loam	Loam silt loam	Silt loam silty clay loam	Loam silt loam silty clay loam	Silty clay loam	Stony loam silt loam	Silty clay loam

GLACIAL SANDSTONE AND SHALE SOILS

	Terrace soils (second bottom)				Flood plain soils (first bottam)		
Color of soil	Brown	Brownish-gray to gray	Brown	Gray	Brown	Gray	Gray-black
Color and	Yellowish-brown	Mottled gray to yellowish-brown	Yellowish-brown	Mottled gray, yellowish-brown, and rust-brown	Yellowish-brown	Mottled gray, yellowish-brown, and rust-brown	Mottled bluish-gray, gray, and yellowish-brown
character of subsoil	Stratified sand and gravel at 20 to 36 inches	Stratified sand and gravel at 24 to 36 inches	Lower subsoil heavy (silt and clay)	Lower subsoil heavy (silt and clay)			
Topography	Level	Level	Level	Level	Level	Level	Level
Natural drainage	Good	Poor	Fair to good	Very poor	Good	Very poor	Very poor
Series	**Chenango**	**Braceville**	**Mentor**	**Tyler**	**Chagrin**	**Holly**	**Papakating**
Important textures	Loam silt loam	Loam silt loam	Silt loam	Loam silt loam	Loam silt loam	Silt loam silty clay loam	Silty clay loam

associated related variations in the natural drainage of the lands, which range from low-lying, level, swampy tracts to rolling uplands subject to erosion.

Within the region designated on the outline map is included an area of old glacial drift, probably of about the same age as the deposits of the Cincinnati region. This area includes eastern Knox and Licking and parts of adjoining counties. Here the topography is rolling. The differentiation from the adjacent younger glacial drift is not pronounced as far as soils are concerned. Additional detailed studies of the soils in this region may reveal important differences.

The soils of the region, having been derived largely from non-calcareous shales and sandstones, are naturally low in lime and for the most part acid. The degree of acidity is variable. However it is not uncommon for the heavier soils to be slightly calcareous at a depth of four or five feet, even tho the upper three feet is acid thruout. In parts of northeastern Ohio the practice of liming the soil has been followed for many years, and, as a result, the surface soil in cultivated fields may not show an acid reaction.

SOILS OF THE GLACIAL SANDSTONE AND SHALE REGION

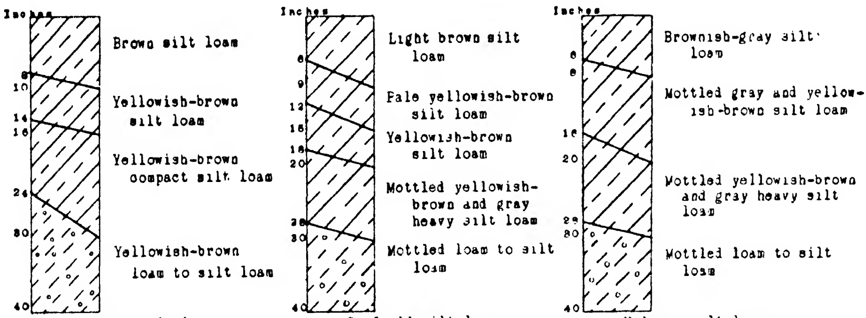
A. Glacial Soils

As a result of the different conditions of topography and drainage under which the soil material has existed as well as of variations in parent material, a number of soils, differing considerably in their characteristics and also in their agricultural value, have been developed. These have been grouped into the following series: Wooster, Canfield, Rittman, Ellsworth, Volusia, Mahoning, Trumbull, and Chippewa. In addition there are shallow soils (over bedrock), which have been included in the Lordstown and Allis series.

Wooster series.—The surface soils of the Wooster series are brown to yellowish brown; the subsoils yellowish brown, free from mottling, and only slightly heavier than the surface soil. The lower subsoil below 24 to 30 inches is a gravelly glacial drift. Sandstone fragments are common on the surface and thruout the soil. These soils occupy the more rolling portions of the upland where both surface and underdrainage are good. The Wooster series has its best development in those parts of the region where very fine grained sandstone makes up a large part of the glacial drift. Like other members of this group the Wooster soils are usually acid. Wooster loam and silt loam are important types.

Wooster silt loam is one of the soils on the Experiment Station farm at Wooster. It is considered one of the best wheat soils in the State.

Canfield series.—These soils differ from the Wooster series chiefly in not being so well underdrained, as is shown by a mottled condition in the lower subsoil. The surface soil is light brown to grayish-brown, and the subsurface to 16 or 20 inches is a pale yellowish-brown. This is underlain by a mottled brown, yellowish-brown, and brownish-gray lower subsoil which is somewhat more compact but only slightly heavier than the surface soil. The substratum is similar to that of the Wooster series. These soils occur on broad divides in association with the Wooster soils and elsewhere on gently rolling areas. The surface drainage is good, but the underdrainage is only fair. Because of the porous nature of the subsoil, the underdrainage can be readily improved by tiling. Canfield silt loam is the important type. It occurs on the Station farm at Wooster and also on the Mahoning County Experiment Farm. This soil is only slightly less valuable than the Wooster soil for agricultural purposes.

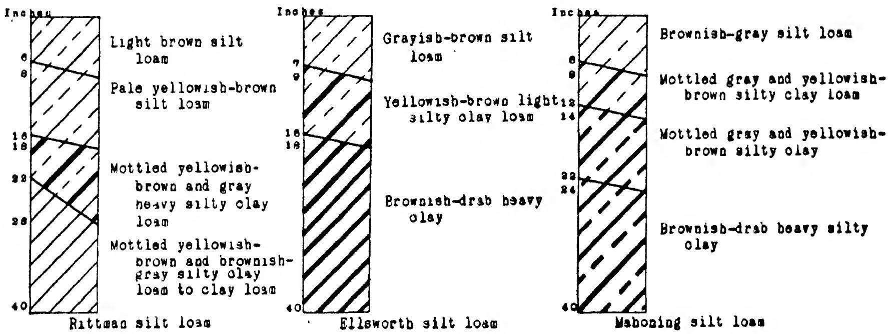


Wooster silt loam Canfield silt loam Volusia silt loam

Rittman series.—The surface soil of this series is a light brown to grayish-brown and the subsurface a pale yellowish-brown. The upper subsoil from 16 to 24 or 30 inches is much heavier than the soil above and rather compact and impervious. In the Rittman silt loam the texture is a heavy silty clay loam, and the color is mottled yellowish-brown and yellowish-gray. The lower subsoil is lighter in texture and more friable, consisting of a gravelly clay loam to light silty clay loam, which is noncalcareous to at least four feet. It is not uncommon for the glacial drift to be slightly calcareous below five feet, however this condition is not so pronounced as in the Ellsworth and Mahoning soils. The upper three feet of the soil is commonly acid in reaction. The topography is undulating to

gently rolling, and the surface drainage is good. Because of the tight impervious subsoil the underdrainage is only fair and could be improved by tiling. The most important type is Rittman silt loam.

Ellsworth series.—The Ellsworth series includes soils with a grayish-brown surface and a yellowish-brown upper subsoil, underlain at 15 to 24 inches by a heavy brownish-drab to olive-drab clay which extends to a depth of 36 inches or more. The lower subsoil below 40 or 48 inches is in places moderately calcareous; the surface soil, however, is generally acid in reaction. These soils have been formed from glacial material derived largely from shale, and hence contain much smaller quantities of coarse sandstone fragments than the Wooster and Volusia soils. The topography is gently rolling, and the surface drainage good, but owing to the heavy impervious subsoil, the natural underdrainage is poor. Ellsworth silt loam and silty clay loam are important types.



Volusia series.—This series is characterized by a brownish-gray surface soil, a mottled-gray and yellowish-brown subsurface, and a highly mottled subsoil. The subsoil is only slightly heavier than the surface soil. Sandstone fragments are common on the surface and thruout these soils. As a general thing the Volusia soils show a higher degree of acidity than the Wooster and Canfield soils. These soils occupy undulating to very gently rolling areas. The surface drainage is fair, the underdrainage poor. Volusia loam and silt loam are important types. The latter soil occurs on the Mahoning County Experiment Farm in association with Canfield silt loam.

Mahoning series.—The Mahoning series includes soils with brownish-gray to gray surface soils and mottled-gray and brownish-yellow subsurface. Below about 15 inches the subsoil is a mottled-gray and yellowish-brown silty clay, which grades into a brownish-drab heavy silty clay. This heavy subsoil extends to a

depth greater than 36 inches. Below 40 to 48 inches the substratum is commonly slightly calcareous. Few rock fragments are to be found on the surface or thruout the three-foot soil section. These soils occupy gently undulating areas. The natural drainage is poor owing to the smooth surface and heavy impervious subsoil. Important types are Mahoning silt loam and silty clay loam. Mahoning silty clay loam is one of the types on the Trumbull County Experiment Farm, and on the Northeastern Test Farm at Strongsville.

Trumbull series.—The Trumbull series includes soils with light gray to gray surface soils and highly mottled subsoils, colored gray, yellowish-brown, and rust-brown. These soils are commonly very acid. They occupied flat to depressed areas and have poor surface and underdrainage. Many areas are "swampy tracts". On the heavier members of the series tile drainage is difficult owing to the tight impervious nature of the subsoil. Such areas are best adapted to permanent pasture. Trumbull loam, silt loam, and silty clay loam are important types. The silty clay loam is also one of the types on both the Trumbull County Experiment Farm and the Northeastern Test Farm.

Chippewa series.—The surface soil of this series is dark gray to grayish-black and the subsoil is mottled bluish-gray, gray, and yellowish-brown. The topography is level and the natural drainage poor. Altho occurring in much the same topographic position as a considerable portion of the Trumbull soils, the Chippewa series is not extensive. The chief type is the Chippewa silty clay loam.

B. Shallow Glacial Soils (over sandstone or shale)

Thruout the region there are numerous areas of bedrock, either sandstone or shale, within the subsoil at such shallow depth as to materially modify the agricultural value of the land. Where the bedrock is within three feet of surface the soils have been included in either the Lordstown or Allis series.

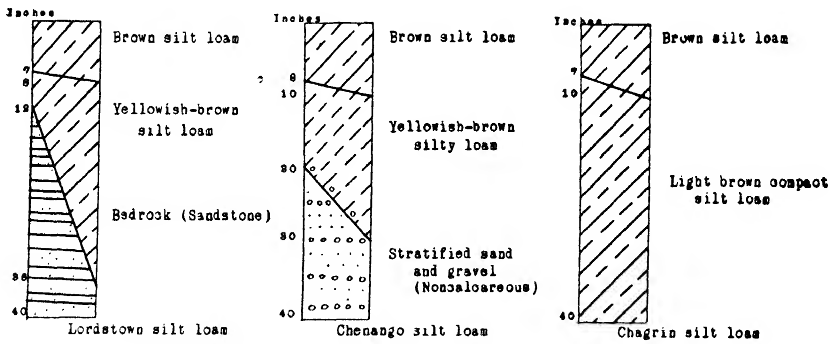
Lordstown series.—This series includes soils with brown surface soils and yellowish-brown subsoils where sandstone or shaly sandstone is within 36 inches of the surface. The soil commonly contains numerous sandstone fragments and bowlders, in fact the subsoil may be in part at least residual from sandstone. The most extensive areas are associated with outcrops of sandstone and conglomerate, which form numerous "ledges" in certain northeastern Ohio counties. These soils are on ridge tops and slopes where the

covering of glacial drift is thin. They are naturally well drained, in fact the shallower areas tend to be drouthy. Lordstown stony loam and silt loam are the most extensive types.

Allis series.—The surface soils of the Allis series are brownish-gray and the subsoils are mottled yellowish-gray, gray and yellowish-brown and are very heavy in texture. Shale and shaly sandstone occur at 12 to 36 inches. Sandstone fragments are common on the surface, where the bedrock is mixed shale and sandstone. The topography is commonly gently undulating and the natural drainage poor. Allis silty clay loam is the chief type.

C. Terrace Soils

Associated with the upland soils are various terrace or second bottom soils. These are in the valleys of present or former streams and are commonly spoken of as "second bottom lands." They are not subject to overflow, except in extremely high floods. Two groups have been recognized. The first is characterized by layers of stratified sand and gravel in the lower subsoil which were deposited by streams coming from the melting ice that existed in the region during the glacial period. These soils have been included in the Chenango and Braceville series.



The second group includes old-stream or alluvial deposits which have been left as terraces or second bottoms as a result of the downward cutting action of more recent streams. The lower subsoils consist chiefly of silt and clay rather than sand and gravel. These soils have been grouped in the Mentor and Tyler series.

Chenango series.—The surface soils of this series are brown, and the upper subsoils are yellowish-brown. The lower subsoil below 20 or 24 inches consists of stratified sand and gravel, in which sandstone and shale make up a large percentage of the coarse material. In places the gravel is coated and sometimes cemented

together with calcium carbonate, but limestone pebbles are exceedingly rare. Chenango soils occupy level to gently undulating tracts and occur as terraces or second bottoms. Because of the gravelly substratum the natural drainage is good. In places gravel comes so close to the surface (10-15 inches) as to make the soil drouthy. Chenango loam and silt loam are important types.

Braceville series.—The Braceville series includes soils with brownish-gray to gray surface soils underlain by a mottled-gray and yellowish-brown subsoil. In the better drained areas the subsurface may be only slightly mottled. The lower subsoil consists of stratified sand and gravel, usually at a depth of 24 to 36 inches. This soil is in level areas in terraces where the movement of water thru the underlying gravels has been so restricted as to produce poor drainage. The important types are Braceville loam and silt loam.

Mentor series*.—The Mentor soils have brown to grayish-brown surface soils and yellowish-brown subsoils, which are usually somewhat heavier in texture than the surface soils. These soils are essentially free from mottling to a depth of 30 inches or more. The lower subsoil consists of silt and clay. Gravel, if present, is in limited amounts. These soils, on level terraces or second bottoms in old valleys, have been formed by the weathering of stream deposits laid down by slow moving or slack water. The topography is level and the drainage good. Where the subsoil is heavy the underdrainage is fair only. Mentor silt loam is the chief type.

Tyler series.—This series has gray surface soils and mottled subsoils, varying in color from gray to yellowish-brown to rust-brown. The lower subsoil is heavy. The topography is level and the natural drainage poor. The principal types are Tyler loam and silt loam.

D. Flood Plain Soils

These soils are first bottom lands and are subject to annual overflow. They have been deposited by the present streams, and are the wash from the surrounding uplands, where the bedrock consists primarily of sandstone and shale. Three series have been recognized—the Chagrin, Holly, and Papakating.

Chagrin series†.—The surface soils of this series are brown; the subsoils, light brown to yellowish-brown. To a depth of three feet or more the subsoil shows little change in texture or color.

*This series was called the Holston in the soil survey reports for a number of northeastern Ohio counties. The name Holston will be used for a somewhat similar soil outside the glacial region.

†These soils were included in the Huntington series in soil survey reports for several northeastern Ohio counties.

These soils, which are in level tracts adjacent to streams, are subject to overflow. They are utilized chiefly for hay and pasture. Where under cultivation, corn is the chief crop. The most important representative of the series is Chagrin silt loam.

Holly series.—The Holly series includes alluvial soils with gray surface and mottled-gray, yellowish-brown and rust-brown subsoils. The topography is level and the drainage poor. Furthermore these soils are subject to annual overflow. Because of these unfavorable conditions the Holly soils are used chiefly for pasture. Holly silt loam and silty clay loam are important types.

Papakating series.—This series has gray-black surface soils. The subsoils are mottled bluish-gray, gray, and yellowish-brown. As they are in the lowest parts of the flood plains of the streams of the region, they are naturally poorly drained, and subject to annual overflow. Tile drainage is necessary before these lands can be utilize for anything but pasture. Papakating silty clay loam is the chief type.

COWS ON PASTURE NEED OTHER FEED

WEEKLY PRESS BULLETIN

Maximum milk production may be maintained by feeding green forage or silage and a little grain as the pasture fails during the heat of summer, says A. E. Perkins, assistant in dairying at the Ohio Agricultural Experiment Station.

Only a little grain is needed to maintain high production in early summer when pasture usually furnishes an abundance of succulent, easily masticated feed. With the coming of hotter weather and the maturing and drying of the grasses the addition of either a palatable roughage or more grain is necessary to keep production at a high level.

During drouth the feeding of a green crop such as oats and field peas, alfalfa, clover, soybeans, or green corn is a good practice. With this practice extremely heavy grain feeding is not necessary to prevent a decrease in production.

A reserve supply of silage to be used at this time will take the place of a green forage crop. In fact many dairymen prefer silage, thus avoiding the work of harvesting a green crop in small quantities. Corn when ensiled will provide more feed per acre than green corn cut at earlier stages or than any of the other green crops.

CORN AND HOG RATIO IN OHIO

J. I. FALCONER

There is usually a more or less close relation between the prices of corn and hogs. In the table is given the monthly ratio between the price of corn and hogs as found by dividing the farm price of 100 pounds of pork by the farm price of one bushel of corn. The ratio varies from year to year and from month to month. The average ratio for Ohio for the last 15 years has been 1:11.5, which is to say, that hogs have sold by the hundred at a price equal to the price of 11.5 bushels of corn. The prices used are the farm prices of Ohio corn and of Ohio hogs as given by the United States Crop Reporting Service. During this period the ratio varied from 6.7 in October 1919, to 20.0 in March and April, 1926. In 1910 the ratio was wide, indicating profit in pork production. There was a wide ratio again in 1916, in 1921 and 1922, and again in 1926. In June, 1925, the ratio was 9.7, by March, 1926 it had reached 20.0.

At the present time the relation between the price of hogs and corn is very favorable to feeding. A study of the figures for a period of years shows that it has generally been from four to six years from one period of wide margin to another. This would seem to indicate that the favorable ratio will continue thru 1926. Below is given the number of months from high point to low point, and from low point to high point for the past 15 years.

March 1913—High	
	25 months down
April 1915—Low	
	23 months up
March 1917—High	
	31 months down
Oct. 1919—Low	
	28 months up
Feb. 1922—High	
	29 months down
July 1924—Low	

CORN-HOG RATIO IN OHIO

Number of bushels of corn which equals in price 100 pounds of hog

	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
January	16.7	13.0	15.6	12.7	10.5	10.7	11.0	12.0	11.1	10.1	13.4	16.3	11.9	9.7	8.1	18.7
February	16.6	9.9	14.9	13.4	9.0	11.3	11.9	11.5	11.5	10.1	14.8	19.3	11.1	9.2	8.0	19.5
March	15.1	9.0	17.1	13.2	9.0	11.6	13.8	11.2	12.1	10.0	17.0	18.6	10.4	9.4	10.4	20.0
April	13.4	10.4	17.0	13.0	8.5	13.2	13.0	11.0	11.3	10.0	15.4	16.6	10.0	9.5	11.4	20.0
May	11.4	9.5	15.1	11.8	9.5	12.6	9.5	10.5	11.5	8.9	13.9	16.1	9.1	9.0	10.0	....
June	10.2	9.0	14.2	11.0	9.3	12.2	9.0	11.2	10.7	7.4	12.7	15.7	7.6	9.6	9.7	....
July	10.5	9.0	13.9	11.4	9.7	12.6	8.8	11.3	11.5	8.3	14.8	15.8	8.0	7.5	11.4	....
August	10.8	10.4	13.9	12.0	9.0	12.0	8.1	11.8	10.7	9.5	16.1	14.0	8.3	8.3	11.6	....
September	10.4	10.8	11.8	10.9	9.4	12.0	10.2	11.5	8.8	10.1	13.1	13.0	9.5	8.1	12.2	....
October	9.5	11.7	11.4	10.1	10.4	10.6	9.3	10.7	6.7	12.1	13.9	13.9	8.9	8.4	14.8	....
November	10.0	13.0	11.9	10.8	10.0	11.0	10.6	11.8	7.3	14.0	16.8	12.3	8.4	8.5	18.0	....
December	12.4	15.8	11.4	11.3	10.9	10.3	12.0	10.8	10.5	13.4	16.8	11.8	8.7	8.0	18.3	....
Average	12.2	11.0	14.1	11.8	9.6	11.7	10.6	11.3	10.1	10.9	14.9	15.3	9.3	8.8	12.0	....

COMPARATIVE PRICES OF OHIO FARM PRODUCTS

J. I. FALCONER

As a whole the prices of Ohio farm products are now about 60 percent above the so-called prewar level. In 1920 prices fell to unusually low levels; from 1922 to 1924 there was some improvement. In 1925 considerable improvement was in evidence and this condition has prevailed thus far in 1926. Some products, however, have not yet shown this tendency to advance in price. The accompanying table, which is based on Ohio farm prices, shows that there is now a wide variation in the comparative price level of our farm products. Lambs and wool have brought relatively good prices for the last four years, and still rank high in spite of somewhat lower prices for wool this year. Poultry and eggs rank next to sheep in price level for the last five years. Dairy products, which are our greatest source of income, have maintained a level of price considerably above the average for the five-year period and are still on a comparatively good price level. Potatoes this spring have reached the highest level of any of the staples. Wheat, corn, oats, hay, beef, and hogs have been the products with prevailing low prices; but, of these, wheat and hogs are now above the general price level, beef has been showing improvement, while oats and horses are the only staple products which now have a price below the prewar level.

Index Numbers of Prices of Ohio Farm Products

	1921	1922	1923	1924	1925	Average 1921-25	April 1926	May 1926
Corn	93	99	132	152	171	129	105	104
Wheat	138	117	114	122	171	132	164	162
Oats	94	97	119	119	115	109	101	98
Potatoes	174	177	143	134	175	160	389	377
Hay	94	85	88	112	88	93	112	108
Eggs	153	136	140	145	162	147	153	155
Chickens	187	172	170	180	188	179	216	210
Hogs	113	121	100	108	157	120	160	176
Beef cattle	110	107	114	115	126	114	123	125
Lambs	143	176	186	194	220	184	182	205
Sheep	99	134	144	150	168	139	144	157
Wool	111	178	227	208	217	188	200	185
Veal	123	120	127	128	138	127	150	149
Milch cows	120	112	114	114	121	116	122	125
Horses	72	66	62	58	58	63	65	63
Butter	155	143	168	167	170	161	173	165
Milk	168	142	178	159	184	166	161	183
Average	132	127	134	133	159	137	155	160

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

Since January there has been a tendency for the general price level to fall. This was especially noticeable during the first three months of the year. Whether the movement will continue seems to be a matter of uncertainty among students of prices. Few, however, anticipate a rise in the immediate future. As a whole the price level of Ohio farm products has been maintained since the first of the year, with resulting improvement in the purchasing power of Ohio farm products. It is the general opinion that such further improvement as there may be during the remainder of the year will be due rather to lower prices for commodities purchased than to higher prices for farm products.

A consideration of the wage level of farm and factory workers, as shown by a comparison of the wages of New York factory workers and Ohio farm wages, will show that the disparity between the two still persists. It is this difference which brought about the net movement from farm to town of 901,000 people in 1925, and 679,000 people in 1924. It is estimated that the net decrease in the farm population in the United States in 1925 was 479,000. The results will be to the advantage of those who remain in farm work.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Ohio farm wages	Non-agricultural products	Farm prices U. S.	Farm prices Ohio	Purchasing power of Ohio farm products
1913	102	....	104	105	100	104	102
1914	100	100	102	97	102	105	105
1915	103	101	103	101	100	106	103
1916	130	114	113	138	117	121	93
1917	181	129	140	182	176	182	100
1918	198	160	175	188	200	203	103
1919	210	185	204	199	209	218	104
1920	230	222	237	241	205	212	92
1921	150	203	164	167	116	132	88
1922	152	197	145	168	124	127	84
1923	156	214	166	171	135	134	86
1924	152	218	165	162	134	133	87
1925	161	223	165	165	146	159	99
1925							
January	163	223	156	165	146	155	95
February	164	220	....	167	146	155	95
March	164	224	....	165	151	159	97
April	159	218	163	162	147	158	99
May	158	221	....	161	146	162	104
June	160	220	....	163	148	165	105
July	163	220	168	164	149	166	102
August	163	222	....	164	152	163	99
September	163	223	....	163	144	157	96
October	160	225	173	164	143	151	94
November	160	226	....	166	144	157	98
December	159	229	....	165	143	158	99
1926							
January	159	229	160	165	143	156	98
February	158	225	....	164	143	156	99
March	154	229	....	162	140	155	101
April	153	....	167	161	141	155	101
May	....	....	....	....	....	160	....

NEW MONOGRAPH BULLETINS

No. 389, Protein Requirement of Dairy Cows, by A. E. Perkins. This bulletin reports to date the results of experiments started in 1911 to determine the effect of the long continued use of dairy rations departing markedly from the accepted standards of protein content. Data are presented which indicate that the actual protein requirement is less than is prescribed in the older standards. Variety in the ration is thought to have had an important bearing on the favorable results secured with feeds low in protein.

No. 390, The Control of Smuts of Wheat and Oats, with Special Reference to Dust Treatment, by R. C. Thomas. The treatments recommended for the control of stinking and loose smuts of winter wheat and the smuts of oats are based on experiments in which various poisons and combinations were thoroly tested. The results of the experiments are summarized. Directions are given for the application of the more practical dust and wet formulas.

No. 391, Fruit Varieties in Ohio, I, by J. H. Gourley and C. W. Ellenwood. This is the first of a series of bulletins planned to report on varieties under observation at the Station. Some of the varieties are comparatively new, to the State; others are older varieties of merit not often included in lists of recommended varieties; still others are seedlings produced by this or other experiment stations. This number of the series illustrates and describes the Ensee, Gallia Beauty, Summer Rambo, and Baltimore apples and the Caco grape.

No. 392, The Forty-fourth Annual Report, by Director C. G. Williams. In popular style the Director presents in the hundred pages of the bulletin practical lessons gleaned from the recent research and experimental work of the Station.

No. 393, Spraying Program for the Orchard and Fruit Garden, by H. C. Young, J. S. Houser, and F. H. Ballou, representing the departments of Plant Pathology, Entomology, and Horticulture, respectively. This popular and practical bulletin gives general suggestions concerning spraying, dusting and other methods of application, materials and specific formulas and directions for the sprays or other treatments necessary for the control of the many diseases and insect enemies of orchard and garden fruits in Ohio.

No. 394, Dependable Fruits, by J. H. Gourley and C. W. Ellenwood. This number supersedes Bulletin No. 313, bearing the same title and published in 1917. Fruits recommended for commercial planting, for the home orchard or garden, and for trial in Ohio are listed and briefly described.

The Monograph Bulletins are sent free upon request by postal card or letter addressed to the Experiment Station, Wooster, Ohio.

The Bimonthly Bulletin

Vol. XI, No. 5 Sept.-Oct., 1926 Whole No. 122

Ohio Agricultural Experiment Station

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OHIO AGRICULTURAL EXPERIMENT STATION
Wooster, Ohio, U. S. A.

The variety plum orchard in rear. An Orchard Day group in foreground, 1925

BIMONTHLY BULLETIN

OF THE

Ohio Agricultural Experiment Station

VOL. XI, NO. 5 SEPTEMBER-OCTOBER, 1926 WHOLE NO. 122

FERTILIZERS FOR WHEAT

ROBERT M. SALTER

A five-year study of the cost of growing wheat in Greene County, Ohio, made by agricultural economists reveals the interesting fact that, on a group of farms having an average wheat yield of 17.4 bushels per acre, it required just 16.9 bushels to pay the cost of raising the crop, including land rental, man and horse labor, seed, fertilizer, and machinery charges. During the 10-year period ending with the 1925 crop, Ohio farmers produced an average yield of 16.35 bushels per acre. Since in Greene County most of the wheat follows corn, disking being the only soil preparation, and since the fields on the average are of good size, the land level, and the amount of fertilizer used very moderate, the cost of growing wheat is certainly not higher than on the average farm of the State. It is obvious, that as now being handled, wheat is not a highly profitable crop on the average farm in Ohio.

More and better fertilizers needed.—While there is still considerable opportunity for increasing the yields by the selection of improved varieties, earlier plowing of oats stubble and better preparation of the seed bed, adoption of better crop rotations, and greater efforts to control disease, the greatest opportunity to profitably increase the yield undoubtedly lies in the more careful selection and generous use of fertilizers for the crop. In good seasons it is possible in Ohio to raise as much as 40 or even 50 bushels of wheat per acre with good soil management. In the last two years a number of men have qualified for the 40-bushel wheat club of Ohio by raising more than 400 bushels of wheat on 10 acres of land. On the experiment station farm at Wooster, one tract of land farmed for thirty-one years in a rotation of potatoes, wheat, and clover, with no other treatment than an occasional liming and the regular use of

TABLE 1.—Results of Fertilizer Applications to Wheat on Unmanured Land

County	Soil types under experiment	Duration of test*	Fertilizer equal to 250 pounds per acre of analysis shown			Increase for					
			Ammonia	Phosphoric acid	Potash	Phosphoric acid		Potash†		Ammonia‡	
						Wheat	Hay	Wheat	Hay	Wheat	Hay
		Years	Pct.	Pct.	Pct.	Bu.	Lb.	Bu.	Lb.	Bu.	Lb.
Trumbull	Mahoning silty clay loam; Trumbull silty clay loam	9	3.2	12.8	3.0	10.90	1,009	0.96	—292	0.29	76
Cuyahoga	Mahoning silty clay loam; Trumbull silty clay loam	30	11.6	10.2	20.0	7.47	773	1.08	—137	2.96	158
Mahoning	Canfield silt loam; Volusia silt loam	8	3.2	12.8	3.0	11.46	626	0.51	152	1.65	222
Wayne	Wooster silt loam	31	11.6	10.2	20.0	7.92	629§	1.40	701	7.89	697
Hancock	Miami silty clay loam	13	5.8	7.7	8.0	5.10	642	1.38	227	0.43	—113
Paulding	Paulding (Brookston) clay	13	5.8	7.7	8.0	1.53	369	1.07	—149	3.52	12
Madison	Miami silty clay loam; Brookston silty clay loam	6	2.2	10.2	9.2	8.18	375	2.48	346	—0.10	46
Miami	Crosby silt loam; Brookston silty clay loam	14	5.8	12.8	4.0	11.46	839	4.01	72	0.45	—57
Montgomery	Miami silt loam	21	5.7	7.7	4.0	6.48	648	2.30	131	2.09	—60
Hamilton	Miami silt loam; Brookston silty clay loam	12	5.8	12.8	4.0	8.06	415	1.07	182	1.49	113
Clermont	Clermont silt loam; Rossmoyne silt loam	11	5.8	12.8	4.0	4.22	300	1.95	330	5.12	390
Meigs	DeKalb silt loam; Meigs silty clay loam	21	5.7	7.7	4.0	6.18	248	1.68	170	2.53	187
Washington	Meigs silty clay loam	10	5.8	12.8	4.0	6.02	456	.34	13	3.45	160
Belmont	DeKalb silt loam	8	2.9	12.8	3.2	3.34	400	1.75	155	1.19	380
Average			5.8	10.8	7.0	7.02	552	1.57	136	2.35	159

*1925 results not included.
†Increase is for potash when used in addition to phosphoric acid.
‡Increase is for ammonia when used in addition to phosphoric acid and potash.
§Increase is for two years of hay following wheat.

770 pounds of a complete fertilizer, divided equally between the potatoes and wheat, has given an average yield for the entire period of 38 bushels per acre. Four times in the 31 years this tract has yielded more than 50 bushels per acre, reaching its maximum of 55 bushels in the good wheat year of 1902.

Field experiments in fourteen counties.—The Ohio Station has been conducting field experiments involving the use of fertilizers on wheat in 14 counties of the state for periods varying from 7 to 32 years. The crop rotation is corn, oats or soybeans, wheat, and clover in all counties except Wayne where it is corn, oats, wheat, clover, and timothy, and Belmont where it is corn, wheat, clover, timothy. The crops are all harvested off the land and no manure returned on any of the fertilized plots considered. The fertilizing materials in all cases are acid phosphate, muriate of potash, and nitrate of soda, used singly or in combination. The older experiments at Wooster and Strongsville have demonstrated that, among the common fertilizer ingredients, these materials are the most efficient carriers of phosphoric acid, potash, and ammonia, respectively, with the exception that sulfate of ammonia may be considered equal to nitrate of soda on soils well supplied with lime. In general, the amounts of the carriers applied were not intended to be the equivalent of any particular commercial mixture. However, since farmers are accustomed to think of fertilizers in terms of commercial analyses, in the discussion which follows, the fertilizer treatments given to the wheat are stated in terms of the analysis had the application been 250 pounds of fertilizer per acre in each case. Attention should be called to the fact that a part of the increase in the wheat crop may perhaps be attributed to the residual effect of fertilizer treatments made on previous crops, while a considerable part of the fertilizer applied to wheat has been passed on to the following hay crop which gets no direct treatment.

Table 1 shows the location of each test, the soil types under experiment, the duration, and the analysis of the fertilizer applied to wheat assuming a total application of 250 pounds per acre. The table also shows the increases in the yield of wheat and of the following hay crop for phosphoric acid alone, for potash when used in addition to phosphoric acid, and for ammonia when used in addition to both phosphoric acid and potash. Table 2 shows the combined values of the wheat and hay increases for phosphoric acid alone, for potash used in addition to phosphoric acid, and for the combination of potash and ammonia when used with phosphoric acid. It also shows the cost of the fertilizers, figuring phosphoric acid at its cost

in straight acid phosphate, potash as the difference between the cost of the potash-phosphoric acid combination at commercial mixed fertilizer prices and the phosphoric acid as acid phosphate, and the ammonia and potash as the difference between the commercial cost of the complete mixture and the acid phosphate. The balance obtained by subtracting the cost of the fertilizer from the value of the increase is also shown. As an average of all tests, 33 percent of the return from applications of phosphoric acid is represented by the increase in the hay crop. Similar figures for the residual effect of the potash and ammonia are 32 and 29 percent, respectively. In general it appears that about ⅔ of the benefit from an application of fertilizer to wheat is realized in the increased wheat crop and ⅓ in the hay crop that follows.

TABLE 2.—Value of Increase in Yields of Wheat and Hay for Phosphoric Acid Alone, for Potash Over Phosphoric Acid, and for Ammonia and Potash Over Phosphoric Acid, Together With Cost of Treatment and Balance

County	Value of increase for phosphoric acid†	Cost of phosphoric acid†	Balance	Value of increase for potash	Cost of adding potash	Balance	Value of increase for potash and ammonia	Cost of adding potash and ammonia	Balance
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Trumbull	20.12	2.32	17.80	−.98	2.32	−3.30	−.05	3.68	−3.73
Cuyahoga	15.15	1.85	13.30	.41	3.94	−3.53	5.30	8.81	−3.51
Mahoning	19.03	2.32	16.71	1.77	2.34	−.57	5.50	3.68	1.82
Wayne	14.63	1.85	12.78	7.01	3.94	3.07	22.11	8.81	13.30
Hancock	11.20	1.39	9.81	3.44	2.81	.63	3.13	5.24	−2.11
Paulding	4.69	1.39	3.30	.22	2.92	−2.70	4.70	5.24	−.54
Madison	3.84	1.85	1.99	5.70	2.44	3.26	5.92	3.84	2.08
Miami	20.63	2.32	18.31	5.54	2.44	3.10	5.67	4.87	.80
Montgomery	12.96	1.39	11.57	3.73	2.44	1.29	5.89	4.83	1.06
Hamilton	13.20	2.32	10.88	2.71	2.44	.27	3.71	4.87	−1.16
Clermont	7.53	2.32	5.21	4.81	2.44	2.37	14.13	4.87	9.26
Meigs	9.59	1.39	8.20	3.38	2.44	.94	7.95	4.83	3.12
Washington	10.95	2.32	8.63	.52	2.44	−1.92	6.03	4.87	1.16
Belmont	7.18	2.32	4.86	3.36	2.36	1.00	7.70	3.57	4.13
Average	12.19	1.95	10.24	2.97	2.72	.25	6.98	5.14	1.84

*Wheat with its straw figured at $1.25 per bushel and hay at $15 per ton.
†Fertilizers figured at the 1926 spring cash prices for acid phosphate and commercial mixed fertilizers.

Phosphates highly profitable.—Acid phosphate, used alone, has given a profitable return in every one of the 14 tests. As an average for all tests 163 pounds of 16 percent acid phosphate costing $1.95 has given an increase of 7.02 bushels of wheat and 552 pounds of hay, having a combined value of $12.19, or a return of 625 percent on the investment. Few investment opportunities are offered the Ohio farmer with as certain promise of a highly profitable return as those in liberal amounts of phosphate fertilizers for wheat.

Greatest return from mixed fertilizers in most counties.—On many soils still larger profit may be expected from either potash-phosphoric acid mixtures or complete fertilizers containing all three fertilizing elements. The results reported in Table 2 indicate that, upon the heavy soils of the Trumbull, Cuyahoga, and Paulding County experiments, acid phosphate alone has been more profitable than either the phosphate-potash combination or the complete mixture. Complete fertilizers have been most profitable in Mahoning, Wayne, Clermont, Meigs, Washington, and Belmont Counties. In all these experiments the soils are of medium texture and light in color due to a rather meager supply of organic matter. In Hancock, Madison, Miami, Montgomery, and Hamilton Counties the phosphate-potash combination has been more profitable than straight acid phosphate or the complete fertilizer. These soils are also of medium texture but on the whole are better supplied with organic matter than those in the counties just considered, which undoubtedly accounts for the relatively poor showing made by the ammonia in the fertilizer.

Mixed fertilizers high in phosphoric acid best.—In most of the tests being considered the return for one dollar invested in phosphoric acid has been higher than for the same amount invested in potash or ammonia. The question may reasonably be raised whether, by increasing the relative amount of phosphoric acid and reducing the amounts of ammonia and potash, the profit from the phosphate-potash mixture and the complete fertilizers might not be increased. The results secured in an 11-year test of different fertilizer analyses at Wooster, as shown in Table 3, support this idea. It will be observed that, in this test, mixed fertilizers have given a greater net return per acre than straight acid phosphate, that increasing the phosphoric acid from 8 percent in the 2-8-2 to 12 percent in the 2-12-2 has added materially to the profit, while increasing the ammonia from 2 percent in the 2-12-2 to 4 percent in the 4-12-2 has lowered the net return. It is also evident that increasing the potash in the fertilizer has been relatively more profitable on corn than on wheat. This experiment supports an analyses of the 2-12-2 or 2-16-2 type for wheat on light colored, unmanured soils of medium texture. Fertilizer tonnage statistics show that the 2-12-2 is at present the most popular mixed fertilizer used in Ohio, a state where more than half of the fertilizer used goes on the wheat crop. The collective judgment of a quarter million farmers is apt to be pretty close to the truth.

The move toward higher analyses fertilizers.—Farmers are using more and more high analysis fertilizers. The old standard 16 percent acid phosphate is giving way to the 20 and 24 percent phosphates. This year considerable amounts of 3-18-3 and 4-24-4 are being sold in substitution for the 2-12-2. The 0-20-20 and 4-24-12 have appeared on the market as substitutes for the 0-10-10 and 2-12-6. By purchasing such high analysis fertilizers the farmer may effect a distinct saving, both in the cost per unit of plant food and in the labor of hauling and applying. So far as the crop is concerned 100 pounds of 24 percent acid phosphate should be fully equal to 150 pounds of the 16 percent grade while 100 pounds of the 4-24-4 should be equal to 200 pounds of 2-12-2.

TABLE 3.—Comparison of Different Fertilizer Analyses Supplemental Fertility Test—Wooster 1915-1925

Plot	Treatment	Increase				Value of increase*	Cost of fertilizer†	Balance
		Corn	Oats	Wheat	Clover			
No.		*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*
2	0—16—0	9.26	3.51	8.15	641	25.91‡	11.63	14.28
3	0—12—4	12.74	7.43	8.87	983	34.45‡	14.53	19.92
8	2— 8—2	11.94	4.55	13.03	691	31.34	15.53	15.81
14	2—12—2	14.67	6.49	14.73	1,057	39.21	17.13	22.08
15	4—12—2	15.55	5.51	14.90	1,087	39.86	20.48	19.38
17	4— 8—4	15.61	5.81	14.04	925	37.74	18.63	19.11
18	4— 8—8	17.68	5.81	14.65	945	40.10	21.13	18.97
Unfertilized yield		54.26	52.33	24.38	3,623	....	....	....

*Corn with its stover figured at 70 cents per bushel; oats with its straw, 40 cents per bushel; wheat with its straw, $1.25 per bushel; clover hay $15 per ton.

†Figured at 1926 spring cash prices at Wooster, Ohio.

‡Value of increase corrected for difference in method of distribution of fertilizer between Plots 2 and 3 and the remaining plots.

How much fertilizer?—The average farmer applies around 200 pounds of fertilizer to wheat. On many farms this represents the only fertilizer used in the rotation. Practice and experiment both indicate that the quantity of fertilizer may be profitably increased to the equivalent of at least 200 pounds for each year of the rotation—that is, 800 pounds in a 4-year rotation. The Ohio Station has a 45-acre tract of land at Wooster which has been in a corn-oats-wheat-clover rotation for 22 years. The treatment has been 10 tons of manure, 1½ tons of limestone and 400 pounds of acid phosphate on corn and 400 pounds of either acid phosphate or a mixed fertilizer on wheat. The average yields of 75.8 bushels of corn, 62.9 bushels of oats, 33 bushels of wheat and 3.05 tons of clover hay are nearly double the average yields for similar land in the county and have been secured with an average annual cash outlay of $5 per acre for lime and fertilizer.

Good practice demands that the wheat crop receive a generous share of the total fertilizer applied during the rotation. Especially is this true where the grass is seeded in the wheat and the meadow receives no direct treatment. Table 4 shows the effect of increasing the amount of fertilizer given to wheat in a 4-year rotation of corn, oats, wheat, clover at Wooster, where the total fertilizer used during the rotation, 1,000 pounds of 2-8-2, remains the same. It will be noted that, except for clover on Plot 5 which gets a direct fertilizer treatment, the yields of both wheat and hay, and with them the value of the increase per rotation, increase directly as the proportion of the fertilizer applied to the wheat increases, the most profitable plot being Plot 11 where the entire 1,000 pounds of fertilizer is given to wheat. Had the fertilizer used on corn on Plot 7 contained more potash it is probable that this plot would have compared more favorably with Plot 11 getting all of the fertilizer on the wheat. In general, it is believed that the wheat crop may well receive about ⅔ of the total fertilizer for the rotation, putting the remaining ⅓ on the corn. This means that a good standard of application for wheat is 400 to 500 pounds per acre of a fertilizer containing around 16 percent of total plant food or the equivalent of this amount in higher analysis goods.

TABLE 4.—Effect of Increasing the Proportion of Total Fertilizer Given to the Wheat Crop Wooster, 11-Year Average

Rotation: Corn, oats, wheat, clover
Basic treatment: All plots, 2 tons ground limestone on corn, no manure used

Plot	Fertilizer applied to each crop. (1,000 lb. 2-8-2 per rotation)				Increase in yield due to treatment				Value of increase per rotation
	Wheat	Clover	Corn	Oats	Wheat	Clover	Corn	Oats	
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Bu.*	*Bu.*	*Dol.*
5	250	250	250	250	9.65	907	9.70	5.74	27.95
6	333	....	333	333	12.30	526	11.77	6.82	30.28
8	500	....	500	....	13.03	691	11.94	4.55	31.64
11	1,000	....	....	....	14.90	1,065	8.34	2.50	33.44

*Corn with its stover figured at 70 cents per bushel, oats with its straw 40 cents per bushel, wheat with its straw, $1.25 per bushel, and hay $15 per ton.

Manure and acid phosphate for wheat.—On livestock farms producing manure sufficient for a liberal dressing of 10 to 12 tons per acre in a 4-year rotation, the choice of fertilizer for the wheat crop should probably be limited to acid phosphate. In a test at Wooster where all the crops, except the wheat grain, grown in a 4-year rotation of corn, soybeans, wheat, clover are fed or go into the manure as bedding and thence back to the land, together with 400 pounds of acid phosphate and 2 tons of limestone on corn and

300 pounds of acid phosphate on wheat, the average yield of wheat for 16 years has been 33.9 bushels, which compares favorably with the best fertilized plots on unmanured land. While, in general, it appears logical to give most of the manure to the corn crop and rely largely on fertilizers for the wheat, there is no doubt but that where the supply of manure permits, a light fall or winter top-dressing on the wheat crop may materially benefit the wheat and improve the stand of clover following. Especially is this true on light colored soils not well supplied with organic matter.

Spring dressing with nitrogenous fertilizers.—Following wet, open winters, especially on light colored soils of a sandy or medium texture, the supply of available nitrogen in the soil may be greatly depleted thru leaching. Under such conditions wheat usually starts its spring growth slowly and the yield may be impaired. A light top-dressing of nitrate of soda or sulfate of ammonia, applied in March or early April at a time when the wheat plants are not wet with dew or rain may be profitably made in such cases. One hundred pounds of nitrate of soda or 75 pounds of sulfate of ammonia per acre is suggested. The fertilizer may be distributed by hand, put on thru the fertilizer attachment of a disk grain drill, or mixed with dry sand or soil to give bulk and applied with a lime sower. On dark colored soils such applications are not recommended since they are apt to be less needed and may increase the danger of lodging.

TABLE 5.—Suggested Use of the Ohio Standard Fertilizers on Wheat

Kind of soil	Other treatment		
	Manure	Clover	Neither
Sands	Phosphate*	2–12–2†	3–12–4
Other light colored soils	Phosphate*	2–12–2†	3–12–4
Peats and mucks	Phosphate*	0–14–4	2–12–6
Other dark colored soils	Phosphate*	0–14–4	2–12–2†

*By phosphates are meant acid phosphate, bone meal or basic slag.
†For the 2-12-2 the 2-16-2, 3-18-3, or 4-24-4 can be substituted.

Suggested use of the Ohio standard fertilizers.—In choosing fertilizers the Ohio farmer may well confine his choice to a list of eight high grade analyses, which, together with the phosphates and other pure materials, are known as "The Ohio Standard Fertilizers." This list was selected by agronomists of the Ohio College of Agriculture and the Ohio Experiment Station with the belief that the analyses contained meet all crop and soil requirements of the State and that the elimination of a majority of the analyses on

the market is desirable in the interest of greater economy in manufacturing. The suggested use of these standard fertilizers on wheat is shown in Table 5. The recommendations are not in all cases supported by direct field experiment, but represent the consensus of opinion, based upon all available field experiments, as to what constitutes a proper treatment for the crop.

Fig. 1.—Clover in wheat stubble on limed (left) and unlimed (right) ends of plots in 5-year rotation at Wooster

Column "manure" assumes that 8 tons or more of well preserved manure is used on the wheat crop. Column "clover" assumes that a good clover sod is plowed down at least once in every four years. Column "neither" assumes that manure is not used on the crop and that clover has not been grown systematically in rotation. These analyses are suggested on the basis and with the recommendation that a yearly average of 200 pounds or more per acre be used during the rotation.

TRUMBULL AND FULHIO WHEAT BEST FOR OHIO FARMS

L. E. THATCHER

Trumbull and Fulhio varieties of wheat have more desirable qualities than other varieties generally grown in Ohio, and may be grown to the exclusion of all others on most Ohio farms. This conclusion is based on evidence secured by growing the varieties on the Experiment Station farm at Wooster, and on the district and county experiment farms of the State. The rapid increase in acreage of Trumbull and Fulhio shows that these two varieties are also satisfactory to Ohio farmers.

Too many varieties being grown.—Altho the acreage of Trumbull and Fulhio is large and rapidly increasing in Ohio, too many other varieties are being grown, many of which are low in yield and quality and subject to disease.

A survey made in 1919 by the United States Department of Agriculture showed that Ohio farmers were then growing 40 named varieties on acreages ranging from 400 to 1,133,900; Poole having the largest acreage, 39.2 percent of the total. Mixtures and unknown sorts were grown on 19.3 percent of the total acreage.

A decided change has taken place in the acreage of many of the varieties since 1919, as shown by statistics collected from farmers visiting the Experiment Station exhibit at the Ohio State Fair in 1923, 1924, and 1925. Many of the reports were from central Ohio, altho the State as a whole was well represented.

TABLE 1.—Varieties of Wheat Grown by Farmers Reporting at State Fair

Crop year	Farmers reporting	Counties represented	Varieties reported	Percentage of acre of		
				Poole	Trumbull	Fulhio
	No.	*No.*	*No.*	*Pct.*	*Pct.*	*Pct.*
1923	399	75	48	33.2	22.7	3.8
1924	363	72	38	19.4	36.4	4.3
1925	247	71	32	10.5	48.3	5.8

These reports indicate a decided increase in the acreage of Trumbull and a corresponding decrease in the acreage of Poole, the leading variety in 1919.

Fewer varieties, better quality.—A decided improvement in the quality of wheat delivered to the terminal markets by Ohio growers can be expected as the acreage of Trumbull and Fulhio increases. There will be fewer cars of mixed wheat—mixtures of

hard and soft, red and white, red winter and durum—and of cars grading "smutty". All of these command a market price of 3 to 5 cents per bushel below straight soft red winter wheat.

Since about 20 percent of the cars loaded in Ohio are graded mixed at the terminal market, the loss to the State may easily amount to a million and a half dollars annually. A small amount of hard red winter wheat or soft white wheat in a neighborhood can do much damage, since a mixture of over 10 percent of wheat of classes other than soft red winter is graded as mixed wheat.

Trumbull and Poole as grown on average farm.—The relative purity and quality of Trumbull and Poole as grown on the average farm is shown by a test now in progress at the Station. Poole was chosen as a typical representative of the best of the older varieties grown in the State.

In the fall of 1925, C. E. Dike, assistant in agronomy, secured 108 samples of Trumbull and 30 samples of Poole from Ohio growers, whose names were taken at random from the list secured at the State Fair. An examination of these samples showed very little weed seed and rye in the Trumbull as compared with the Poole.

These samples were seeded separately last fall, each in a row a rod long. Each row produced on the average 600 heads of wheat. Trumbull contained fewer mixed and smutted heads than the Poole as shown by the following counts:

TABLE 2.—Trumbull and Poole Samples Compared

	Trumbull	Poole
Number of rows	108	30
Mixed heads per row		
Maximum	48	420
Minimum	0	2
Average	18	116
Loose smut		
Number rows smutted	4	27
Total number smutted heads	4	157
Average number smutted heads per row	1/27	5 1/2
Stinking smut		
Number rows smutted	9	10
Total number smutted heads	36	267
Average number smutted heads per row	1/3	8 9/10

The greater purity of Trumbull and its comparative freedom from cockle, cheat, and rye are due to the original seed stocks of pure Trumbull. Many Trumbull growers secure a new supply of

"registered" or "certified" seed as soon as they find their own wheat is becoming mixed with other varieties brought in by the neighborhood threshing machine*.

The greater freedom of Trumbull from loose smut and stinking smut (bunt) is due to an inherent resistance to these diseases. Observations of wheat fields over the State for many seasons have convinced the inspectors for the Ohio Seed Improvement Association that both the Trumbull and Fulhio have less disease than most other varieties. Final proof of this is given by experiments in which varieties have been artificially inoculated with disease and grown under controlled conditions.

Resistance to stinking smut tests.—G. H. Stringfield, assistant in agronomy in connection with breeding new strains of wheat at the Ohio Station, and W. H. Tisdale, pathologist, and John H. Martin, agronomist and others of the United States Department of Agriculture working at Davis, Calif., Moro, Or., and Pullman, Wash., found marked differences among varieties in degree of infestation when the seed was dusted with stinking smut spores, as shown in the following table.

TABLE 3.—Percentage of Heads Infected with Stinking Smut

Variety	Ohio Station Test Wooster, Ohio		U. S. Department of Agriculture (Bulletin 1299)
	1925	1926	Average 1919—1921
Trumbull	3.8	7.5	10.0
Fulhio	3.3	8.2	....
Ohio 16983	1.0	3.3	....
No. 6 Jr.	0.8	3.6	....
Kanred	3.0	7.2	9.6
Ridit	0.0	0.0	....
Sherman	0.0	0.0	....
Hussar	0.1	0.0	0.0
S. P. I. 26007	1.4	0.0	....
Ohio Hybrid 1029	4.1	6.2	....
Red Wave	3.3	11.1	58.8
Ohio 18947—Nigger	4.2	5.2	....
Fultz	2.6	17.5	67.3
Ohio 9920	13.9	24.8	....
Nigger	23.1	10.2	59.1
Gladden	1.6	35.3	61.5
Gypsy	10.9	14.1	63.6
Fulcaster	21.6	31.0	56.5
Leap's Prolific	14.2	23.1	58.5
Portage	24.6	29.7	....
Mediterranean	15.2	33.1	63.0
Red Rock	33.5	19.6	51.9
Goens	18.8	30.5	79.6
Poole	6.4	14.9	68.9

Altho some varieties show greater resistance to stinking smut than Trumbull and Fulhio, they possess some undesirable characteristics making them unsuitable for growing in Ohio. Ridit and

*Information on "registered" and "certified" seed wheat can be secured by addressing W. E. Hanger, secretary, Ohio Seed Improvement Association, Columbus, Ohio.

Sherman are late maturing and low yielding. No. 6 Jr. is a soft white wheat which yields well but makes a weak flour, suitable only for pastry purposes. Kanred and S. P. I. 26007 are low yielding hard red winter types.

Many common varieties, otherwise desirable, show heavy infection. The Nigger which makes up about 7 percent of the total state acreage, is largely grown within a radius of 50 miles of Springfield, Ohio. It is significant that the bulk of Ohio's smutty wheat is found in this territory.

Ohio 9920 is very susceptible to this disease, and this is probably its chief weakness. Other varieties easily smutted are Gypsy, Fulcaster, Leap's Prolific, Portage, Mediterranean, Red Rock, Goens, and Poole.

Trumbull, Fulhio, Ohio 16983, and Ohio 18947 (a selection from Nigger) are red winter wheats of good quality and combine a high degree of resistance with other desirable characteristics. Increasing the acreage of Trumbull and Fulhio, together with systematic seed treatment, will greatly reduce the enormous loss from stinking smut, which some seasons in Ohio, amounts to a million and a half bushels of wheat.

Full directions for the use of dust treatments for smuts of wheat and oats are given in Bulletin 390, a copy of which can be obtained from the Station on request.

Resistance to loose smut.—Trumbull wheat, when grown in the neighborhood of fields of varieties heavily infected with loose smut, has shown almost complete immunity. In most cases loose smut in Trumbull fields is confined to heads of other varieties constituting a mixture. Its freedom from loose smut has earned for Trumbull the name of "smut proof" wheat in certain localities.

Preliminary inoculation tests at Wooster with Trumbull, Goens and Gladden, show Trumbull to be immune, whereas Goens, an excellent variety in other respects, is easily infected. Field observations show Fulhio to be fairly high in resistance to loose smut, but not so immune as Trumbull.

R. C. Thomas, associate plant pathologist of the Ohio Station, estimated the loss from loose smut to vary from 1,481,000 bushels in 1919 to 325,000 bushels in 1921. This loss can be overcome most easily by growing the resistant varieties, Trumbull and Fulhio. Controlling the disease by seed treatment is difficult on most farms. The treatment consists of soaking the seed in hot water held at a constant temperature of 129° F. for 10 minutes following a presoaking at a lower temperature.

TABLE 4.—Average Yield Varieties of Wheat on Ohio Experimental Fields

Farm	County	Years	Trumbull	Fulhio	Ohio 9920	Gladden	Portage	Nigger	Fultz	Gypsy	Fulcaster	Mediterranean	Goens	Poole
			Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Station	Wayne	10	34.35	37.29	35.54	36.82	34.83	34.73	33.26	33.87	32.72	33.15	33.31	33.18
Southeastern	Meigs	8	27.01	....	30.92	27.15	28.14	26.97	27.52	25.25	....	26.36	....	25.78
Southwestern	Montgomery	8	31.12	29.30	31.72	28.06	28.10[7]	28.52	30.09	28.65	28.78	....	....	28.20
Miami	Miami	11	32.30	....	29.62[10]	34.62	32.36[10]	30.76	29.42	32.90	....	....	30.83	30.17
Paulding	Paulding	10	29.63	....	....	28.39	26.74	29.76	....	....	....	....	....	....
Hamilton	Hamilton	8	....	30.85	30.29	30.45	28.51	....	....	....	....	....	27.66	....
Clermont	Clermont	9	14.68	....	....	19.40	16.24	....	....	....	....	18.14[8]	....	....
Northwestern	Hancock	8	21.29	....	19.72	22.53	....	....	....	....	18.25	....	....	....
Trumbull	Trumbull	8	30.85	29.83	30.82	32.35	30.49	....	31.78	....	....	....	....	28.83
Northeastern	Cuyahoga	8	29.00	....	30.53	28.88	....	28.30	....	....	....	28.07	....	....
Washington	Washington	8	18.86	....	24.37	25.14	....	25.75	....	....	....	....	....	....
Belmont	Belmont	6	25.19	27.78	28.23	30.52	....	....	....	....	....	....	....	....
Madison	Madison	8	22.98	....	22.26	24.21	....	21.84	....	....	....	....	....	....
Mahoning	Mahoning	8	30.53	32.32	30.50	30.08	....	27.24	31.19	....	....	....	....	27.57

Note: The small figures—7, 8, and 10—indicate number of crops included in the average thus marked.

Trumbull fairly resistant to scab.—General field observations by inspectors for the Ohio Seed Improvement Association, indicate that Trumbull is comparatively free from scab. Fulhio showed a little more scab than Trumbull this year. In 1925, Red Wave and Klondike showed heavy infection with scab in the variety test at Wooster, whereas Trumbull and Fulhio were comparatively free.

Yield is important.—The yields of Trumbull and Fulhio are satisfactory as shown by reports from farmers and as indicated by tests conducted at the experiment farms of the State.

Trumbull and Fulhio compared.—The superiority of Trumbull and Fulhio over common varieties has been shown. It may be necessary to make a choice between Trumbull and Fulhio. In this event, the strong and weak points of each should be considered. A summary of their outstanding characteristics may be helpful.

Fig. 2.—Wheat varieties are grown side by side in tenth-acre plots

The strong points of **Trumbull** are stiffness of straw; early maturity; freedom from loose smut; comparative freedom from stinking smut (bunt) and from scab; non-shattering of grain; high quality of grain and flour, and good average yields. Its chief weak point is a tendency to winter kill in unfavorable situations, where drainage is poor and when seeded late on thin land. However, winter injury can be reduced very materially by timely seeding and by the use of liberal amounts of commercial fertilizer or manure on the spots in the field where winter injury is likely to take place.

Fulhio is somewhat more winter hardy than Trumbull, stools betters, and can be grown successfully where Trumbull winter kills. Its average yield is a little higher than Trumbull. In time of maturity, non-shattering of grain and quality of grain and flour, it is equal to the Trumbull. Its resistance to disease is a little lower, and its straw is a little weaker than Trumbull.

SOYBEAN HAY AND SOYBEAN SILAGE

C. C. HAYDEN AND A. E. PERKINS

The weather is often unfavorable for curing soybeans when they are ready to cut for hay and, since this is also about the season when corn is ready for the silo, the question is often asked, "Is it better to cure the soybeans for hay or put them into the silo with the corn?"

The Department of Agronomy at the Station grew corn and soybeans separately. Part of the soybeans were cured for hay and part were put into the silo with corn at the rate of one part by weight of soybeans to 2.1 parts of corn. When ensiled the beans contained 44.2 percent and the corn 30.2 percent of dry matter. Analyses showed that 2.1 pounds of the soybeans contained about as much dry matter as 1 pound of the cured soybean hay. Therefore, for each pound of hay fed with corn silage to one lot enough of the corn-soybean silage to contain 2.1 pounds of soybeans was fed to the other lot.

In order to bring out the full effect of the dry hay, no other dry roughage was fed; and to prevent covering up the full effect of the protein in the soybeans in the two rations, a grain mixture rather low in protein was fed. The grain mixture consisted of 4 parts ground corn, 1 part bran, and 1 part linseed oilmeal.

The double reversal system of feeding was used and the cows were given all they would clean up readily. The feeding began November 28, the rations were reversed February 15, and the test closed April 18, 1924. Two lots of three cows each completed the test.

The data collected during the first four weeks and for the two weeks after the change in rations were discarded to avoid the effect of the previous ration. The figures for the remaining seven weeks on each ration have been used for comparison.

The following table shows the total production and feeds consumed while the cows were fed each ration.

TABLE 1.—Soybean Silage and Soybean Hay Compared

	Milk Lb.	Fat Lb.	Grain Lb.	Silage Lb.	Hay Lb.
Silage ration	6,046.6	288.40	2,232	14,969	....
Hay ration	5,981.1	285.02	2,254	10,283	2,254
Difference	65.5	3.38	—22	4,686	—2,254
Percent difference	1.08	1.17	— 1	....	....

The difference in production from the two rations was slightly above 1 percent in both milk and fat in favor of the soybean-silage ration. Such a small difference is entirely within the limits of probable error and should not be considered significant.

Of the soybean hay fed, about 13.2 percent consisting of the coarse stems was refused. Lot I, receiving the hay during the second period, refused about 9.4 percent; and Lot II, receiving the hay during the first period, refused about 17 percent. It is difficult to say just what caused Lot I to clean up the hay better than Lot II. There were two conditions which may have had an influence. The cows were receiving alfalfa hay previous to the test and the coarser parts of the soybean hay were less palatable than the alfalfa. The cows in Lot I, without dry roughage for about eleven weeks, may have had a greater desire for dry roughage. However, the loss of the stems from the soybean hay did not seem to influence, to any considerable degree, the production of milk.

The cows of both lots gained weight during the first period and lost during the second period. The gains and losses were nearly equal so that the cows weighed about the same at the close of the test as at the beginning. They had not drawn materially on their bodies for production.

No attempt was made to determine the relative cost of the two methods of handling the soybeans.

CONCLUSIONS

1. This one test is not sufficient to warrant final conclusions but it indicates practically no difference in the feeding value of soybeans preserved by the two methods. Dairymen probably can use either method with equally good results.
2. The cows cleaned up the soybean stems in the silage but refused them in the hay.
3. The loss of 13 percent of the hay in the form of stems did not materially affect the milk production.

Fig. 3.—Starting to pasture

Fig. 4.—Bird at left on all-mash feed, no filth in crop. Bird at right fed scratch grain, notice straw, feathers and other filth separated from feed in crop

THE ALL-MASH METHOD OF FEEDING FOR EGG PRODUCTION

D. C. KENNARD AND R. M. BETHKE

Now that the all-mash method of feeding chicks and growing pullets* has become an established practice as a result of the success many poultry raisers the country over have realized from its use, poultry keepers are keenly interested in the question of employing this method in feeding for egg production. Will it prove as successful in the feeding of layers as it has in the feeding of chicks and growing pullets? From the results of the last two years' experiments involving 2500 layers at the Ohio Experiment Station, it seems that it will.

As the all-mash feeding is such a radical departure from the customary practice of feeding scratch grain and mash, many poultry keepers may hesitate to change from the traditional practice, even tho they may have employed the new method with the young stock. Nevertheless, the all-mash method of feeding for egg production promises to become a general practice. Our first thought was that it would be necessary to feed a part of the mash moistened during the winter months in order to insure the heavy feed consumption essential for winter egg production. During the past year, however, the tests have indicated that moist mash is not necessary, and that the question of moistening the mash may be regarded the same with the all-mash method as with feeding grain and mash. In other words, some will likely be able to secure a few more winter eggs by moistening a portion of the mash, while others will not find it worth while to do so, especially if consideration is given to the extra time, labor, and skill of feeding involved.

ADVANTAGES OF ALL-MASH FEEDING

More sanitary.—The birds eat clean feed from a feeder; whereas, when scratch grain is fed in litter, which is always more or less filthy and musty, they pick up some of the contaminated material along with the grain, especially when they are hungry and greedy. Furthermore, the litter is often damp and as it is difficult to feed just the correct amount of scratch grain, a surplus is sometimes left in the damp litter and becomes contaminated with must or mould before it is finally picked up by the birds. The litter also

*Ohio Exp. Sta. Bimonthly Bulletin Jan.-Feb., 1926.

may become a favorable harbor for disease or parasitic organisms, and the increased consumption of this filthy material due to feeding scratch grain in it offers greater opportunity for birds to become exposed to disease and parasites. That birds do pick up straw, feathers, and manure when eating grain from litter, especially when hungry, is shown in Figure 4.

It enables one to feed a definite ration.—There is no guess work or confusion about what proportion of scratch grain is to be fed.

Less labor and skill of feeding.—That less labor and skill of feeding are required is self evident. Time and labor add to the cost of eggs produced. More attention must be given to economy in this respect, as one of the best methods of increasing net returns is to reduce the cost per dozen eggs. Comparatively few poultry keepers are naturally skilled feeders, so that a method of feeding which requires little skill and at the same time yields the results is desirable. The question of how much scratch grain to feed is a puzzling one for most poultry keepers. The ration is often unbalanced because of feeding scratch grain too liberally. The all-mash method enables one to feed a definite ration so all the birds in the flock get a balanced ration.

How and when to change from old to new method.—The same caution should be exercised in changing from scratch grain feeding to the all-mash method as is exercised in making any other radical change of feeding or management. The best plan, of course, is to start using the new method with the chicks; then there is no change to be made. In the case of hens, the better plan would be to change during April, May, or June, or during the winter moulting period, otherwise egg production may be lowered for a while. When it is desired to place ready-to-lay pullets or laying pullets accustomed to the old method of feeding on the all-mash feeding, it may be expected that four to six weeks will be required for them to become fully accustomed to the new method. Therefore, it would not be advisable to make the change after the pullets have started to lay, or just before they are ready to lay, if a delay in production is not desired. Regardless of the time or age of the birds, the change should be made slowly over a period of at least two weeks, gradually decreasing the scratch grain fed in the litter and adding it coarsely ground or even as previously fed in the litter to the mash. In this way there is no change in the ration and the grain in the mash more quickly accustoms the birds to the all-mash mixture.

Suitable mash feeders.—Ample eating space should be provided. For best results with the all-mash feeding the open box type of mash feeder should be used. The reel mash feeder is especially well adapted for this purpose. The feeder should be only 5 inches deep inside. Three reel mash feeders or similar type of feeders providing 24 feet of eating space should be supplied each 100 layers. The reel mash feeder has the advantage of furnishing ample, well-lighted feeding space and never clogging as hoppers often do. The reel keeps the birds out of the box and prevents their roosting on it at night. This with its elevation off the floor keeps the feed clean, and, being easily accessible, the birds are naturally induced to eat more mash. In locating the feeders it is well to place them so the end of the feeder faces the front of the house, just inside and within two or three feet of the window or open front space to insure an abundance of light.

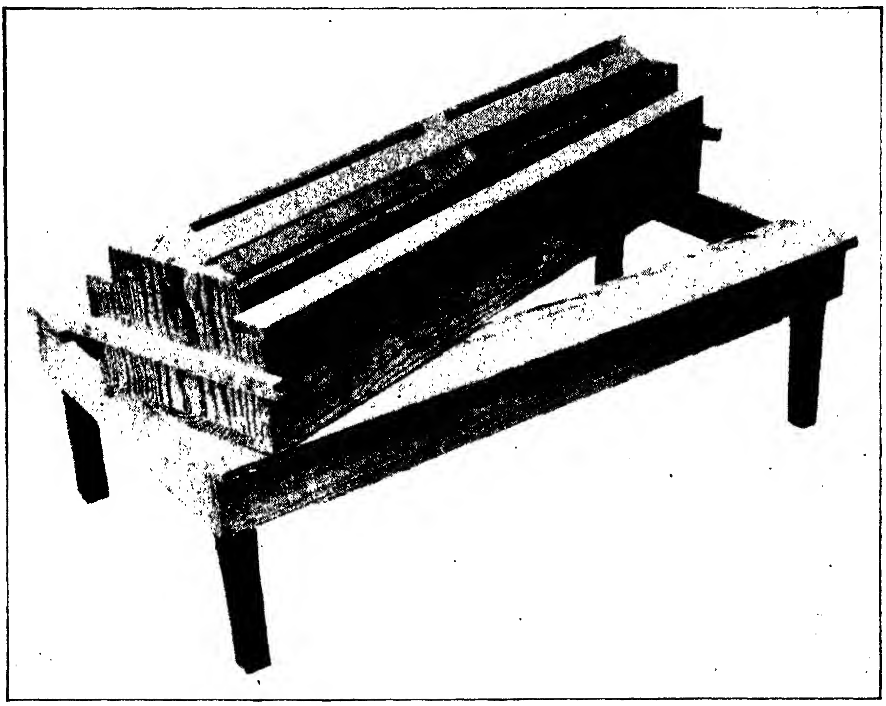

Fig. 5.—The reel mash feeder

Method of feeding.—The all-mash method is simple. The mash is kept before the birds all the time. However, for best results it is desirable to feed daily the amount that will be consumed during the next 24 hours. As the layers will eat more readily of

the fresh mash, the time of feeding should be from 3 to 5 p. m., depending upon the season of the year, so that the birds will go to roost with a well filled crop. The all-mash feeding lends itself well to any of the methods of feeding by means of artificial lights.

The ration.—Generally speaking, the all-mash mixture contains double the amount of grains and one-half the usual amount of protein concentrates, minerals, etc. of the mash of the same ration when fed half scratch grain and half mash. That is, by adding an equal amount of ground or whole grains to the usual mash, all the original mash ingredients become diluted one-half in the final mixture. Take for example one ingredient, meat scraps. The amount usually added to the mash fed in connection with scratch grain is 20 percent; whereas in the all-mash mixture if fed on the same level it would be 10 percent. The following mixtures have proved effective in extensive tests at the Ohio Experiment Station:

1.

Corn, coarse ground	30
Wheat, coarse ground	20
Oats, fine ground	20
Wheat bran	10
Winter wheat middlings (shorts)	10
Meat scraps (medium)	10
Bone meal (chick size)	2
Salt	½

2.

Corn, coarse ground	65
Winter wheat middlings (shorts) or coarse ground wheat	20
Meat scraps (medium)	10
Bone meal (chick size)	4
Salt	1

In preparation of the mash mixtures, it is desirable to have as large a proportion of the mixture in granular form as possible. This is accomplished by grinding the corn so the larger particles are about the size of a half kernel of wheat; the use of medium meat scraps; and chick size granulated bone. The birds like the granular mash better than a fine mash and can eat it more readily.

Skimmilk or buttermilk (liquid, dried, or condensed) will prove a valuable addition to either of the above rations. Milk is valuable for its proteins, minerals, and vitamins. The price of the different forms of milk depends principally upon their content of milk solids. The solid content of liquid skimmilk or buttermilk is usually 7 to 9 percent; condensed buttermilk, 28 to 30 percent; dried buttermilk, 90 to 95 percent. Liquid skimmilk or buttermilk is fed as a drink either in addition to or in the place of water. Condensed buttermilk may be mixed with water, 1 to 2 pounds per gallon, and given as a drink; or a more convenient method is to spread the buttermilk

paste on the wall of the chicken house giving each 100 hens 3 to 6 pounds at noon or about 4 p. m. daily. The dried buttermilk or skimmilk is mixed with the dry mash at the rate of 5 to 10 percent by weight. When milk in any form is supplied 5 percent meat scraps in the mash is sufficient. If liquid skimmilk or buttermilk is given the birds instead of water, and the ration seems too laxative, the bone meal and salt in either formula should be reduced one-half.

Thus far neither of these rations has proved superior to the other. It seems that about equally satisfactory results may be secured from either. Both are incomplete as they stand and require supplementing by a good range, legume hay, green feed, or cod-liver oil.

NECESSARY SUPPLEMENTS TO THE RATION

The foregoing rations can not be expected to prove satisfactory unless they are supplemented by an outdoor range which will provide ample succulent green forage or, if the range become depleted it will be necessary to feed an abundance of green feed such as cabbage, Swiss Chard, alfalfa, clover, or rape. If the birds are confined indoors, is is necessary to feed green feed, alfalfa, clover, or soybean hay, or cod-liver oil, all the year if heavy mortality, low egg production, and poor shell texture of eggs are to be avoided.

The outdoor range.—Undoubtedly the outdoor range of bluegrass and direct sunlight makes the best all-the-year supplement to any ration. This is particularly true of the farm flock where the number of birds is such that suitable range conditions can be maintained. But it is often difficult if not impossible to provide the proper range for large flocks, or limited space may not permit it, and during the winter months the outdoor range can not always be depended upon. Under such circumstances it becomes necessary to keep the birds in restricted yards or indoors. Then the poultry keeper is obliged to give careful attention to the feeding of the supplements described below.

Green succulent feeds.—For supplementing the depleted range from July to December, cabbage and Swiss Chard are probably the most satisfactory. Early cabbage becomes available during July, and the late varieties can be fed well into winter. Following this the golden tankard mangel wurzels may be used to advantage.

Legume hays in place of green feed.—Alfalfa, clover, and soybean hays, in numerous tests conducted by the Ohio Station during the last three years, have proved effective substitutes for succulent green feed for winter feeding. The second or third cutting of

alfalfa or clover is best, as it is the leafy part of the immature plant that carries the valuable properties. Soybean hay should be cut when the seeds or beans are just beginning to form. At this stage there is a rather good yield of hay which carries a large proportion of leafy material rich in protein and vitamins. All of the hays should be carefully cured so as to preserve the green color and high quality. This means that they must be cured without getting wet from rain or dew. In some cases it may be necessary to cure the hay under cover.

Fig. 6.—Pullets eating cut hay from the wire netting basket feeder

Hay can be fed in racks, or cut in ½ inch lengths and fed from wire netting basket feeders, see illustration. Or it may be tied in a bundle and suspended from the ceiling within easy reach of the birds. From November to May as good results were secured from laying pullets confined indoors and fed legume hays as from birds having access to an outside range of bluegrass. During the summer months the birds on range surpassed those kept indoors. Alfalfa and clover leaf shatterings are often available when these hays are being fed other farm animals and can be fed the chickens to good advantage. No benefit was secured from ordinary alfalfa meal mixed in with mash at the rate of 5 percent by weight. Whether the more recent product, alfalfa leaf meal, will prove valuable like the hay remains to be determined. It is surprising how the hay is relished by the birds and the quantity they will eat.

Cod-liver oil.—Cod-liver oil also has proved a very effective substitute for green feed or outdoor range. Altho its use did not improve hatchability, it did increase egg production, produce better

shell texture of eggs, and reduce mortality of birds. When it is desired to use cod-liver oil, the crude medicinal oil of light yellow color is added at the rate of two pounds, or a quart, to each 100 pounds of the mash. It is best to mix the oil with 10 or 15 pounds of the mash or one of its ingredients; then in turn mix this with the remaining 85 or 90 pounds of the mash to be prepared. This secures a finished mixture which is uniform and free from lumpy material.

Weight of layers.—Does the all-mash method of feeding maintain the body weight of the layers? Monthly weight records of pullets taken thruout the year beginning November 1, revealed no difference in the weight of birds fed scratch grain and mash equal parts, or those fed the same ration in the form of all-mash. This is according to expectations for the birds fed the all-mash ration consumed the same proportion of grains; the only difference being that the grain was fed coarsely ground in the all-mash method.

The exercise theory.—Extensive tests with 10,000 chicks and 2500 layers during the last three years by the Ohio Station failed to reveal any benefit from the feeding of scratch grain in litter to either chicks, pullets,† or layers. This is, of course, contrary to the traditional exercise theory; but from the evidence at hand it appears that chickens do not require scratch grain fed in litter either for exercise or for other reasons. Now that more is known as to what constitutes a complete ration for chickens, it seems that the supposed objects for which scratch grain is fed in litter are attained by proper nutrition. Undoubtedly exercise is beneficial to chickens; but it is questionable if any benefit is to be derived from feeding scratch grain in litter to induce young White Leghorn chicks or even the layers to take this particular form of exercise in addition to their natural activities. It is not known as yet whether this method of feeding will prove equally satisfactory with the heavier breeds.

In view of the uniformly good results secured with layers and its obvious advantages, the all-mash method of feeding for egg production promises soon to become a general practice. It should be emphasized, however, that the success of the method depends upon the mash mixture, the supplements employed, and the use of a suitable box-type of feeder, such as the reel mash feeder, which affords ample feeding space. Furthermore, it is difficult to wean the older birds from the habit of eating scratch grain. To avoid this difficulty it is best to start the chicks on all-mash method of feeding.

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†July-Aug., 1926 Mo. Bul. Ohio Exp. Sta.

GRIT REQUIREMENTS OF THE GROWING CHICK

R. M. BETHKE AND D. C. KENNARD

Since the fowl has no teeth with which to grind its feed it is generally thought that some hard, granular material, commonly termed "grit", must be supplied to aid in reducing the feed to fineness in the gizzard. The importance of supplying grit to baby chicks is emphasized by the general recommendation that a drink and sand or a similar material should comprise the "first course" in good chick management to make sure of a grinding mechanism in the gizzard for efficient utilization of subsequent feed.

Numerous practices in poultry husbandry appear to be based on tradition and supposition. The general belief in supplying grit to chickens is about as firmly established as any that can be cited. In fact, it has been so generally accepted that published literature, in so far as the writers are aware, reveals no instance of any one directly questioning the merits of the practice.

In order to obtain definite evidence as to the necessity or merits of supplying grit to chicks the following tests were conducted.

Experiment 1.—Day-old White Leghorn chicks, hatched from eggs of the Station flock were divided into four groups of 18 each and placed in pens 3 by 6 feet. Pine shavings, renewed weekly, were used as litter.

In order to determine whether the relative state of fineness of the ration had any effect, two of the groups, one group having free access to granite grit, the other without grit, were allowed a coarse mash after the first week. The other two groups, one with and the other without grit, received a ration of the same composition but very finely ground.

The ration had the following composition: yellow corn, 56; wheat middlings, 23.5; casein, 15; calcium carbonate, 2; common salt 1; and cod-liver oil, 2.5. Water was supplied as a drink. The growth and mortality record of the chicks is given in Table 1.

The chicks in all four lots did poorly. There was a tendency towards constipation which in part might account for the heavy mortality and slow growth. Aside from this no abnormalities or nutritional disorders were observed. The birds which received grit were no better than those without grit. Likewise, there was no apparent difference between the coarse mash and fine mash groups.

The slightly better weights in the two fine mash groups can be accounted for by the relative percentage of cockerels to pullets, which was much greater in these two groups.

The total feed consumption of the four groups, while low, was nearly the same.

TABLE 1.—Growth of Chicks Receiving a Fine and a Coarse Ration With and Without Grit, Experiment 1

	Fine ground ration				Coarse ground ration			
	Grit		No grit		Grit		No grit	
Age	Surviving	Average weight	Surviving	Average weight	Surviving	Average weight	Surviving	Average weight
Weeks	*No.*	*Grams*	*No.*	*Grams*	*No.*	*Grams*	*No.*	*Grams*
0	18	32	18	32	18	32	18	32
2	16	61	18	57	17	60	17	63
4	15	97	16	98	17	90	17	101
6	14	138	15	145	15	138	16	152
8	14	206	15	206	14	186	16	206
10	14	282	14	284	13	259	16	271
12	14	373	14	395	13	353	16	347

Experiment 2.—We had occasion to test the merit of dried buttermilk as compared to liquid skimmilk as a part of an otherwise complete ration. Similar rations had in the past produced good growth and livability of chicks when grit was supplied. Since we observed no apparent benefits from feeding grit in Experiment 1, it was deemed advisable to employ these milk rations without grit. Accordingly, day-old White Leghorn chicks of the Station's hatching were divided into two groups and placed in the experimental pens as before. Pine shavings were again used as litter.

The ration of Group 1 was a medium ground mash of 66 parts yellow corn, 28.5 parts wheat middlings, 2 parts calcium carbonate, 1 part common salt, 2.5 parts cod-liver oil, and skimmilk ad libitum. Group 2 received a similar ground mash composed of 56 parts yellow corn, 23.5 parts wheat middlings, 15 parts dried buttermilk, 2 parts calcium carbonate, 1 part salt, 2.5 parts cod-liver oil, and water to drink.

The growth and mortality records of the birds to 12 weeks of age are given in Table 2. The birds in Group 1, which received skimmilk, did remarkably well and were fully two weeks ahead of the dried-buttermilk lot at the close of the 12th week. No nutritional or digestive disorders were noted in either group. While there was no group which received grit for direct comparison, it is the authors' belief that no better results would have been obtained

had grit been supplied. To secure additional evidence on the necessity of supplying grit, 6 pullets and 3 cockerels from the skimmilk group and 4 pullets from the buttermilk group were placed in each of two pens of 5 by 6 feet at the end of the 12th week. Pine shavings were used as litter.

TABLE 2.—Record of the Chicks Receiving a Complete Ration Including a Milk Supplement—Without Access to Grit. (Experiment 2)

	Group 1 Liquid skimmilk ad libitum		Group 2 Dried buttermilk 15 percent	
Age	No. surviving	Average weight	No. surviving	Average weight
Weeks		*Grams*		*Grams*
0	26	33	20	33
2	26	78	20	63
4	26	161	20	125
6	25	303	19	219
8	25	491	19	343
10	25	717	19	510
12	25	934	19	704

The all-mash feed was replaced by grain and mash to make the grit requirements supposedly more necessary. Both pens received a mash composed of 70 parts yellow corn, 20 parts wheat middlings, 4 parts bone ash, 5 parts cod-liver oil, 1 part salt, and skimmilk, which remained before them at all times. In addition both pens received a grain mixture composed of 3 parts coarse cracked corn and 2 parts whole wheat. This was placed before the birds for 30 minutes daily in open troughs. One pen was allowed granite grit, while the other received no-grit. The results are given in Table 3.

TABLE 3.—Record After 20 Pullets and 6 Cockerels (in Table 2) Were Equally Divided into Two Pens and Fed a Grain Mixture in Addition to a Mash—With and Without Grit. (Experiment 2 cont'd.)

	Grit		No grit	
Age	No. surviving	Average weight	No. surviving	Average weight*
Weeks		*Grams*		*Grams*
12	13	949	13	954
14	13	1,128	13	1,140
16	13	1,315	13	1,334
18	12†	1,479	13	1,401
19	12	1,540	13	1,515
21	12	1,627	13	1,581
23	12	1,616	13	1,655

*The cockerel and pullet weights were averaged separately and the two averages combined for a general average.

†One pullet died in the 17th week from oviduct trouble.

The birds in both pens made a normal rate of growth with no signs of nutritional or digestive disturbances, and started to lay between the 18th and 19th weeks. The egg production up to the time of slaughter was 8 eggs per bird, the same for both pens. No differences in the amounts of mash and grain consumption were observed.

At the close of the 11th week on this management, the birds in both pens were killed for autopsy examinations—which revealed nothing abnormal. The digestive tracts of the "no-grit" birds apparently were normal and did not differ from those of the grit birds. A rather careful examination of the gizzards indicated that the size of this organ, as well as the thickness and firmness of its musculature, had no relationship to the presence or absence of granite grit. It was observed, however, that the gizzards from the "no-grit" birds contained a few pieces (from 2 to 10) of hard granular material suggestive of small pebbles, while the contents of this organ from the grit birds were approximately from 25 to 33 percent grit. Not knowing how much effect the presence of these few hard granules might have had in the "no-grit" pen, another experiment was conducted with two groups of chicks on screens of hardware cloth to safeguard against the possibilities of the birds picking up grit-like material which might be in the litter.

Experiment 3.—Fifty day-old White Leghorn chicks from the Station poultry plant were divided into two lots of 25 each and placed in the laboratory pens as before. The floor of the pens and brooder were covered with muslin cloth, renewed daily, for the first two weeks. After that the chicks were kept off the floor by means of frames covered with ½-inch mesh hardware cloth elevated 3 inches above the floor. In this way there was no possibility for the chicks to come in contact with the floor and litter.

Each lot received a medium ground mash of 70 parts yellow corn, 20 parts wheat middlings, 5 parts casein, 2 parts bone ash, 1 part salt, 2 parts cod-liver oil, and skimmilk to drink. In addition, one lot had free access to granite grit, while the other had no-grit.

The chicks were allowed to continue under this management until the 10th week, when the cockerels and pullets were placed in separate pens and continued on screens as before (Table 4). To make conditions still more exacting as to the need of grit for grinding purposes, the medium ground mash was replaced by a coarse mixture in which 20 parts of whole wheat replaced the wheat middlings and 2 additional parts of bone ash were added to increase the

mineral content. The corn was also coarsely ground, approximating the size of whole wheat. Otherwise the ration was the same as before.

The cockerels in both lots were killed at the close of the 16th week (see Table 4) and a thoro examination made of the digestive tract. No differences were noted between the grit and "no-grit" individuals. The gizzards of both groups appeared to be of the same size, and there was no noticeable difference in the thickness or firmness of the musculature. The gizzard content of the "grit" birds was heavily interspersed with granite grit; while that of the "no-grit" birds was free from granular material.

TABLE 4.—Grit Versus no Grit—When Birds Are Prevented From Coming in Contact With Floor or Litter by Means of Cloth and Wire Screens. (Experiment 3)

	Grit		No grit	
Age	No. surviving	Average weight	No. surviving	Average weight
Weeks		*Grams*		*Grams*
0	25	33	25	32
2	25	86	25	76
4	25	143	25	117
6	25	234	24	201
8	23	353	23	323
10	23	575	23	482
12*	23	704	22	607
14	23	867	21	764
16	21	1,008	20	954
18†	9	1,037	10	1,018
20‡	9	1,162	10	1,215
22	9	1,287	10	1,349
24	9	1,360	9§	1,450
28	9	1,352	9	1,445

*Cockerel and pullet weights averaged separately and combined for general average. Cockerels were separated from pullets at close of 10th week—and the medium ground mash was replaced by a coarse mash. (See text).

†Pullets only. Cockerels killed for examination at close of 16th week.

‡Given one half pint of whole corn daily in addition to coarse mash.

§Pullet died from oviduct trouble.

The pullets were continued on the same ration and management (Table 4). The "no-grit" lot started to lay at the close of the 19th week; the "grit" lot started one week later. At the beginning of the 20th week, one-half pint of whole yellow corn was fed to each group daily in addition to the mash of coarse-ground corn and whole wheat. Two additional parts of cod-liver oil were added to the mash in order not to reduce the total anti-rachitic vitamin intake. The birds were allowed to remain on this management until they were 28 weeks of age, with no visible difference in the appearance and behavior of the two groups. The total egg production was 120 for the "grit" group, and 126 for the "no-grit" group.

DISCUSSION

The data as presented in the tables indicate that the generally accepted belief that grit is necessary for the growing chick and the common practice of supplying grit are based on theory and tradition rather than facts. Altho there is no evidence that grit or like material is detrimental to the chick, the necessity of supplying it does not appear essential.

The chicken has a natural craving for almost any kind of grit-like material. There appears to be no satisfactory explanation for this manifestation. The accepted theory has been that the grit is required for grinding purposes, or "hen's teeth". It has also been thought of as partially serving as ballast in the digestive tract and it may have some function in that respect. It seems, however, more plausible to think that the chicken's craving for grit is prompted by the desire to satisfy its mineral requirements. Under natural conditions the chicken is obliged to depend upon grit-like material for certain essential minerals and may instinctively eat or crave the grit even if adequate minerals are supplied from other sources.

How much grinding action grit exerts in the gizzard of a chicken, we are unable to state. However, if grit, as commonly thought, exerts a grinding action of importance and thereby indirectly aids digestion, the birds receiving grit and those not receiving grit should have shown a difference in growth, behavior, etc. Since no differences were observed, even between the groups receiving a coarse feed mixture with and without grit, it would seem that the grinding action of grit is of minor importance, and that the quality of the ration in conjunction with the digestive fluids of the alimentary tract are the factors which determine the rate of growth and well-being of a chick.

SUMMARY

No benefit resulted from the feeding of grit (granite) to baby chicks to 12 weeks of age or to maturity in the three experiments reported.

Birds which did not receive grit appeared to utilize coarse ground feeds and whole corn and wheat as effectively as those that had access to grit for growth and egg production.

Grit may, however, serve an important function as a source of essential minerals if the ration is deficient in this respect.

SUPPLEMENTS THAT IMPROVE THE RATION FOR LAYERS

D. C. KENNARD AND R. M. BETHKE

A number of rations appear to be equally effective for chickens; but all combinations of feed stuffs composed of grains, their by-products, and most packing house by-products are alike in that certain supplements are essential for building up a complete ration. Such a ration is composed of five parts:

1. Grains and their by-products.
2. A protein concentrate.
3. Minerals.
4. Vitamins A and B.
5. Anti-rachitic factor, or vitamin D.

Since it has become the general practice to use a protein concentrate with the grains and their by-products, deficiencies are usually concerned with the last three factors. As certain supplements may determine the value of most rations, a study of some of the more promising ones is being made by the Ohio Station.

The control ration employed without any supplement in the first year's work (Table 1) was one extensively used by poultry keepers. It consisted of **grain** yellow corn 2, wheat 2, oats 1 and **mash** equal parts of ground yellow corn, ground oats, wheat bran, winter wheat middlings, and meat scraps. The all-mash method of feeding was employed; so the grain was ground and fed as a part of the dry mash, using equal parts by weight of grain and mash. No scratch grain was fed. The composition of the mash (combined grain and mash) as fed was ground yellow corn 30, ground wheat 20, ground oats 20, wheat bran 10, winter wheat middlings 10, meat scraps 10. Oyster shells and grit were available at all times. To this control ration the various supplements were added and fed to lots of 50 White Leghorn pullets to each ration. All pullets except those on bluegrass range were confined indoors where direct sunlight was mostly excluded. The results are shown in Table 1.

The failure of the control ration to meet the requirements of laying pullets confined indoors where little direct sunlight was available, is evident. The failure appears to be due to lack of vitamin A and the anti-rachitic factor (direct sunlight) since marked improvement resulted when the supplements carrying these

factors were employed. The alfalfa hay proved surprisingly beneficial. While the skimmilk increased egg production, it failed to prevent heavy mortality. This is according to expectations, for skimmilk is a poor source of vitamin A, or the anti-rachitic factor. The cod-liver oil, in both tests, was effective in preventing mortality and increasing egg production. Of all the supplements, however, the bluegrass range and direct sunlight was the best. It was observed that the pullets receiving cod-liver oil produced eggs with much stronger shells than the other groups confined indoors. Cod-liver oil, therefore, appears to be not only a preventive but a remedy for weak or defective egg shells.

TABLE 1.—Egg Production and Mortality of Laying Pullets and Hatchabality of Their Eggs as Affected by Different Supplements to the Same Basal Ration. 1924-1925

Ration	Eggs per bird Nov. 1 to		Increase of eggs over basal ration	Mortality	Hatchability		
	Mar. 1	Oct. 1 11 mo.			Total eggs set	Fertile	Chicks hatched*
	No.	*No.*	*Pct.*	*Pct.*	*No.*	*Pct.*	*Pct.*
Experiment 1 at Wooster							
Basal ration only	29	95	....	44	530	94	31.1
Basal ration plus skimmilk to drink (no water)	36	134	41	32	685	91.2	49.0
Basal ration plus alfalfa hay, chopped	39	125	32	12	645	94.0	41.7
Basal ration plus cod-liver oil, 2 percent	30	141	48	10	749	88.4	33.2
Basal ration plus bluegrass range	36	159	67	8	1,007	97.7	61.9
Experiment 2 at S. E. Test Farm							
Basal ration only	24	89	....	40	279	92.8	46.3
Basal ration plus cod-liver oil, 2 percent	31	124	40	6	361	90.9	36.9
Basal ration plus bluegrass range	36	150	69	14	518	87.5	58.3

*Percent of fertile eggs. Average of 9 different hatches.

Nutritional roup was responsible for a large part of the mortality in the groups receiving the control ration and this ration plus the skimmilk, which indicates the deficiency of vitamin A in these rations.

Nine different tests of hatchability of the eggs were made during the hatching season. The eggs from the pullets on bluegrass range hatched better than any of the indoor groups. No improvement in hatchability resulted from the cod-liver oil. It appears that direct sunlight is essential for best hatchability of eggs.

In the experiments reported in Table 1, practically all direct sunlight was excluded from the pens. Lath bafflers in open front spaces provided the ventilation. The results in Table 2 were secured with as much direct sunlight as could be admitted thru the open fronts of the houses. The dry-mash feeders were located in the direct sunlight to afford additional exposure of the birds.

Since the failure of the control ration of Table 1 appeared to be largely due to lack of vitamin A, the control ration in Table 2 was better fortified in this respect by the use of a large proportion of yellow corn. In spite of the increased amount of vitamin A and the admission of direct sunlight into the pen, the control ration proved distinctly inferior to the rations to which the supplements were added. We are unable to explain why the group of birds receiving the cod-liver oil did not lay more eggs than those receiving the control ration. However, the value of cod-liver oil in the ration proved beneficial in that the mortality of birds was much less when compared to the group receiving the control ration. The soybean hay gave surprising results. This group of birds was confined indoors and apparently did as well before March 1 as those having access to an outdoor range of bluegrass. However, this did not hold true after May 1.

TABLE 2.—Egg Production and Mortality of Laying Pullets and Hatchability of Their Eggs as Affected by Different Supplements to the Same Basal Ration. 1925-1926

Ration	Eggs per bird Nov. 1 to		Increase of eggs over basal ration	Mortality to June 1	Hatchability		
	Mar. 1	June 1			Total eggs set	Fertile	Chicks hatched*
Experiment 3 at Wooster	*No.*	*No.*	*Pct.*	*Pct.*	*No.*	*Pct.*	*Pct.*
Basal ration only	27	61	....	22	906	95.2	36.1
Basal ration plus alfalfa hay, chopped	31	81	33	10	1,354	94.7	59.3
Basal ration plus clover hay, chopped	34	73	20	28	1,026	95.9	55.2
Experiment 4 at S. E. Test Farm							
Basal ration only	19	61	....	32	325	76.4	31.0
Basal ration plus soybean hay	38	98	61	16	637	82.0	60.5
Basal ration plus cod-liver oil, 2 percent	17	62	2	8	382	90.1	25.8
Basal ration plus bluegrass range	37	101	66	4	944	73.4	60.0

Basal ration:
Ground yellow corn, 65; ground wheat, 20; meat scraps, 10; bone meal, 4; salt, 1.
Oyster shells and grit in hoppers.
*Percent of fertile eggs. Average of 13 different hatches.

The mortality in Experiment 3 was largely due to an outbreak of chicken pox and roup during March and April. The alfalfa hay group was least affected by the epidemic, only one bird dying from this cause 10 were lost from the group receiving clover hay and 7 from the basal ration.

Hatchability of the eggs was distinctly improved by the legume hay supplements. In agreement with last year's results cod-liver oil again failed to improve hatchability.

SUMMARY

A complete ration is required for the layers. Grains and their by-products and packing-house by-products do not usually make a complete ration and require certain supplements.

The best supplement to any ration is direct sunlight and green forage.

During late fall and winter, alfalfa, clover, soybean hay, and cod-liver oil prove valuable supplements for the usual rations employed in the feeding of poultry.

Successful feeding for egg production depended largely upon the proper use of the supplements in question.

The legume hays improved hatchability of eggs, whereas cod-liver oil did not.

OHIO SPORTSMEN PLANT 45,000 FOREST TREES

WEEKLY PRESS BULLETIN

Forty-five thousand forest tree seedlings were planted this year on Ohio farms and in municipal parks by twenty-six chapters of the Isaac Walton League. This work was done in accord with a plan outlined by Edmund Secrest, state forester.

"Each chapter is asked to cooperate with farmers by planting at least one acre a year. The state furnishes the trees, the league members do the planting, the farmer agreeing to protect his young trees.

"The league will thus not only aid in the conservation of game by establishing coverts, but it will also aid the farmer in the reclamation of his waste land. The farmer has sometimes suffered from the depredations of careless sportsmen, and it is hoped that this plan will lead to a better understanding and cooperation.

"The league is a national organization largely of professional and business men who are sportsmen and outdoor enthusiasts as well. This year 26 of the 126 Ohio chapters planted forest trees. The New Philadelphia chapter planted 3½ acres at Schoenbrunn Park, the site of the first white settlement in Ohio. The Springfield chapter planted fourteen acres of the new municipal forest which is sponsored by that chapter."

OHIO FARM EXPENSES

J. I. FALCONER

Since July, 1925 the Bimonthly Bulletin has been publishing an index of the prices of Ohio farm products. Below is given an index of Ohio farm expenses. Most of the major items of expense, with the exception of rent and interest, are included. The weights given for the different items of expense have been computed and checked from many sources, including the detailed data on expenses from more than 5,000 farms in various sections of Ohio. The weighting indicates the relative importance of the different items. The index numbers for the price level of the several classes of expenses have been computed from sales prices in Ohio, with the exception of those on buildings, clothing, furniture, groceries, and fuel. For these latter the price index of the Bureau of Labor has been used. The table shows that farm machinery, which includes automobiles and tractors, is the group having the lowest price level. Taxes is the highest. As a whole expenses were 10 points less in the spring of 1926 than in 1925.

Index Number of Ohio Farmers' Expense 1909-1913=100

Item	Weight	Index number for April			
		1923	1924	1925	1926
Labor	14	150	163	163	167
Machinery	10	125	146	138	138
Feed	14	140	127	153	127
Taxes	8	215	211	218	219
Fertilizer	4	141	139	146	148
Building	10	188	182	180	175
Clothing	14	196	191	190	180
Furniture	4	184	175	170	164
Groceries	11	141	141	159	151
Fuel	2	218	181	174	175
Miscellaneous	9	156	150	161	151
Total	100				
Weighted index		164	162	168	161

FREIGHT RATES ON OHIO LIVESTOCK

GEO. F. HENNING

Most livestock from Ohio goes to market over the railroad. As a result the transportation cost is expressed in freight rates. Nearly all livestock moves in carloads and thus at a carload rate. In addition livestock has been given a special commodity rate.

Our present freight rates on livestock have been in effect since January 1, 1922. Previous to 1915 there were few changes in livestock freight rates. Then on January 4, 1915, they were advanced 5 percent; on June 27, 1917, 15 percent; June 25, 1918, 25 percent; August 26, 1920, 40 percent. On January 1, 1922, the Inter-State Commerce Commission ordered a 10 percent reduction. This rate has been in effect since that date.

TABLE 1.—Carload Rates on Cattle (single deck), and Calves, Hogs, Sheep, or Lambs (double deck), From Four Points to Four Markets, in Cents Per 100 Pounds, 1915-1926

Shipping point.	Market	Present rate*	Aug. 26, 1920 to Jan. 1, 1922†	June 25, 1918 to Aug. 26, 1920†	June 27, 1917 to June 25, 1918†	Jan. 4, 1915 to June 27, 1917†	Previous to 1915†
Chillicothe							
To	Cleveland	28.0	31.0	22.0	17.5	15.2	14.5
	Pittsburgh	29.0	32.0	23.0	18.5	16.0	15.25
	Baltimore	44.5	49.5	35.5	28.5	24.7	23.5
	Jersey City	47.5	52.5	37.5	30.0	26.3	25.0
Coshocton							
To	Cleveland	22.0	24.5	17.5	14.0	12.1	11.5
	Pittsburgh	22.5	25.0	18.0	14.5	12.6	12.0
	Baltimore	40.0	44.5	31.5	25.0	21.9	20.75
	Jersey City	43.0	47.5	34.0	27.0	23.4	22.25
Columbus							
To	Cleveland	24.0	26.5	19.0	15.0	13.1	12.5
	Pittsburgh	25.5	28.5	20.5	16.5	14.5	13.5
	Baltimore	43.0	47.5	34.0	27.0	23.4	22.25
	Jersey City	46.0	51.0	36.5	29.0	25.2	24.0
Lima							
To	Cleveland	25.0	27.5	19.5	15.5	13.4	12.75
	Pittsburgh	29.0	32.0	23.0	18.5	16.0	15.25
	Baltimore	44.5	49.5	35.5	28.5	24.7	23.5
	Jersey City	47.5	52.5	37.5	30.0	26.3	25.0

*Present rates obtained from various tariffs.
†Previous rates obtained from Freight Traffic Book published by Traffic Publishing Co.

An index of freight rates on livestock at the present time stands at 190 when the rates previous to 1915 are used as the base, or 100. In Table 1 the rates are given on single decks of cattle, and on double decks of calves, hogs, and sheep, from four Ohio shipping points.

There are really only three rates for livestock at the present time. One rate applies on single decks of cattle and double decks

of calves, hogs, or sheep, which is the same from one point to another. Another rate applies on single decks of hogs and calves, which is higher than the previous rate on cattle, etc. A third rate on single decks of sheep is the highest of all. For example, the present rate between Columbus and Cleveland on a single deck of cattle, and a double deck of hogs, calves, sheep, or lambs is 24 cents per 100 pounds; on a single deck of hogs and calves the rate is 27.5 cents, and on a single deck of sheep or lambs 30 cents. The single deck of lambs carries the highest rate.

TABLE 2.—Rates on Cattle (single deck), Calves, Hogs, and Sheep (double deck), From Points in Ohio to Various Markets, 1915-1926, in Cents Per 100 Pounds

Shipping point	Market	Previous rate*	Aug. 26, 1920 to Jan. 1, 1922*	June 25, 1918 to Aug. 26, 1920†	June 27, 1917 to June 25, 1918†	Jan. 4, 1915 to June 27, 1917†	Previous to 1915†
Coshocton	Cleveland	22.0	24.5	17.5	14.0	12.1	11.5
Columbus	Cleveland	24.0	26.5	19.0	15.0	13.1	12.5
Chillicothe	Cleveland	28.0	31.0	22.0	17.5	15.2	14.5
Bellefontaine	Cleveland	24.0	26.5	19.0	15.0	13.1	12.5
Greenville	Cleveland	25.5	28.5	20.5	16.5	14.2	13.5
Van Wert	Cleveland	25.5	28.5	20 5	16.5	14.2	13.5
Lima	Cleveland	25.0	27.5	19.5	15.5	13.4	12.75
Washington C. H.	Pittsburgh	28.5	31.5	22.5	18.0	15.5	14.75
Coshocton	Pittsburgh	22.5	25.0	18.0	14.5	12.6	12.0
Columbus	Pittsburgh	25.5	28.5	20.5	16.5	14.2	13.5
Chillicothe	Pittsburgh	29.0	32.0	23.0	18.5	16.0	15.25
Bellefontaine	Pittsburgh	31.0	34.5	24.5	19.5	16.8	16.0
Greenville	Pittsburgh	31.0	34.5	24.5	19.5	16 8	16.0
Van Wert	Pittsburgh	31.0	34.5	24.5	19.5	16.8	16.0
Lima	Pittsburgh	29.0	32.0	23.0	18.5	16.0	15.25
Columbus	Baltimore	43.0	47.5	34.0	27.0	23.4	22.25
Lima	Baltimore	44.5	49.5	35.5	28.5	24.7	23.5
Washington C. H.	Baltimore	44.5	49.5	35.5	28.5	24.7	23.5
Chillicothe	Baltimore	44.5	49.5	35.5	28.5	24.7	23.5
Coshocton	Baltimore	40.0	44.5	31.5	25.0	21.9	20.75
Cleveland	Baltimore	40.0	44.5	31.5	25.0	21.9	20 75
Cincinnati	Baltimore	47.5	52.5	37.5	30.0	26.3	25.0
Toledo	Baltimore	43.0	47.5	34.0	27.0	23.4	22.25

*Present rates obtained from various railroad tariffs.
†Previous rates obtained from Freight Traffic Book published by Traffic Publishing Co.

A majority of Ohio's livestock moves on the rate which applies on single decks of cattle and double decks of hogs, calves, and sheep or lambs. Hence, this rate is used in the tables.

Table 1 gives an approximate idea of the cost of shipping livestock to the terminal markets from different sections of Ohio. Of course the points nearer the market pay less and those farther away more. However, most of the rates in the State to the nearby terminal markets are below 35 cents per 100 pounds.

Table 2 gives the rates that are in effect at present and also the rates during the several stages of increases for the last 10 years. This gives an approximate idea of the actual increase in cents per

100 pounds from different sections of Ohio. Thus the rate from Columbus to Cleveland has increased 13.5 cents and from Columbus to Baltimore 24 cents.

In 1914, 1.5 percent of the Ohio farm price of hogs went to freight from Columbus to Cleveland; at the present time, using the first six months of 1926 as an average, 1.9 percent of the live price goes for freight. With cattle the situation is different. In 1914, the freight between Columbus and Cleveland was 1.9 percent of the farm price and at the present time it is 3.2 percent. This difference between the percent of the Ohio farm price of cattle and hogs going for freight rates from 1914 to 1926, is due to the fact that the present price of hogs is fairly high, the index being 165, while the Ohio cattle index is at 125.

TABLE 3.—Present Rates* Applying on Cattle, (single deck), Calves, Hogs, and Sheep (double deck) From Points in Ohio to Various Markets, in Cents Per 100 Pounds

Shipping point	Destination				
	Cleveland	Pittsburgh	Cincinnati	Baltimore	Jersey City
Coshocton	22.0	22.5	....	40.0	43.0
Columbus	24.0	25.5	....	43.0	46.0
Chillicothe	28.0	29.0	19.5	44.5	47.5
Bellefontaine	24.0	31.0	22.0	....	....
Greenville	25.5	31.0	....	....	....
Van Wert	25.5	31.0	....	....	....
Lima	25.0	29.0	....	44.5	47.5
Washington C. H.	....	28.5	18.5	44.5	47.5
Cleveland	....	....	....	40.0	43.0
Cincinnati	....	....	....	47.5	50.5
Toledo	....	....	....	43.0	46.0

*Rates obtained from railroad tariffs.

From Table 3 one may get a fair impression of the freight rates on livestock from various sections of Ohio to different market centers. For example, Chillicothe may ship to Cincinnati for a freight rate on cattle, etc., of 19.5 cents per 100 pounds; to Cleveland for 28 cents; to Pittsburgh for 29 cents; to Baltimore for 44.5 cents; or to Jersey City for 47.5 cents. Notice the Jersey City rate is 3 cents above the Baltimore rate from all points.

INDEX NUMBER OF FREIGHT RATES ON OHIO FARM PRODUCTS

GEO. F. HENNING

Since a large portion of the products of agriculture moves to market by freight, freight rates are a good indication of the cost of transportation.

It is generally understood that the freight rate structure is decidedly complicated and complex in its makeup. As a result an index of freight rates must be rather general.

Ohio is located in the railroad area for rate making purposes known as truck line territory. This area includes the states of New York, Pennsylvania, Ohio, Indiana, Illinois, the greater portion of West Virginia, Virginia, and New Jersey. A large portion of Ohio's agricultural products moves to market within this territory.

Freight rates, unlike the prices of most commodities which fluctuate from day to day, week to week, or month to month, remain the same for definite periods. This is because the Inter-State Commerce Commission approves or disapproves increasing or reducing freight rates. Naturally the same rates stay in effect for a rather long period.

Several changes in freight rates have taken place in the last 10 or 12 years. From 1910 to 1915 few changes were made. On January 4, 1915, freight rates were advanced 5 percent; June 27, 1914, 15 percent; June 25, 1918, 25 percent; and August 26, 1920, 40 percent. Then on January 1, 1922 the Inter-State Commerce Commission authorized a 10 percent reduction in rates on agricultural products and on July 1, 1922, the 10 percent reduction was made effective on all other commodities.

TABLE 1.—Index of Freight Rates for Ohio

Period	Index
Previous to 1915	100
January 4, 1915 to June 26, 1917	105
June 27, 1917 to June 24, 1918	120.7
June 25, 1918 to August 25, 1920	150.9
August 26, 1920 to December 31, 1921	211.3
January 1, 1922* to present time	190.2

*This date applies on agricultural products. On other commodities the date would be July 1, 1922.

An index of freight rates for farm products in the Ohio territory may be constructed as shown in Table 1 by letting the rates in effect previous to 1915 be represented by 100.

The index on freight rates at the present time, as shown by the table, is 190. This would seem to indicate that freight rates have not fallen as far as the price of most other commodities. The Bureau of Labor Statistics gives 162 for their index of prices for all commodities during 1925. During 1924 the same index stood at 152, and in 1923 at 156. The index of farm prices in Ohio was 159 in 1925, 133 for 1924, and 134 for 1923. Thus freight rates at the present time are relatively high as compared to other commodities and farm prices in Ohio.

It might be pointed out here, however, that, from a strictly selfish point of view, the Ohio farmer enjoys a better market outlet for his products with relatively high freight rates than with low rates. This is because of the nearness of Ohio farmers to market centers. With high freight rates the market area of a commodity is more limited than with low rates, especially on bulky products because the transportation cost is prohibitive for the products produced at a greater distance from the market. In a later article freight rates from some of these far distant points to eastern markets will be given.

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

As in 1925 the purchasing power of Ohio farm products rose above the so-called pre-war normal in the early summer months. Good prices for wheat, hogs, and dairy products were influential in maintaining this price level. The outcome for the remainder of the year now depends largely upon the weather and the progress of crops.

It is now thought that the volume of industrial output in 1926 will exceed that of any previous 12-month period and that the industrial profits will be the greatest of any peace time year. Wages are high, credit conditions are easy, the consuming power of the country is enormous. This would indicate a continuation of the present good demand for farm products.

The spring pig survey, made as of June 1, showed 1 percent fewer pigs saved in the Corn Belt this spring than last. In Ohio there were reported to be 6.7 percent fewer sows than last year.

This would seem to indicate no material drop in hog prices for the current year. The number of sows bred or to be bred for fall farrowing, however, indicates an increase of about 25 percent in the fall pig crop for the Corn Belt, which would point to a material increase in the number of hogs coming to market in 1927 over 1926.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Ohio farm wages	Non-agricultural products	Farm prices U. S.	Farm prices Ohio	Purchasing power of Ohio farm products
1913	102	....	104	105	100	104	102
1914	100	100	102	97	102	105	105
1915	103	101	103	101	100	106	103
1916	130	114	113	138	117	121	93
1917	181	129	140	182	176	182	100
1918	198	160	175	188	200	203	103
1919	210	185	204	199	209	218	104
1920	230	222	237	241	205	212	92
1921	150	203	164	167	116	132	88
1922	152	197	145	168	124	127	84
1923	156	214	166	171	135	134	86
1924	152	218	165	162	134	133	87
1925	161	223	165	165	146	159	99
1925							
January	163	223	156	165	146	155	95
February	164	220	....	177	146	155	95
March	164	224	....	165	151	159	97
April	159	218	163	162	147	158	99
May	158	221	....	161	146	162	104
June	160	220	....	163	148	165	105
July	163	220	168	164	149	166	102
August	163	222	....	164	152	163	99
September	163	223	....	163	144	157	96
October	160	225	173	164	143	151	94
November	160	226	....	166	144	157	98
December	159	229	....	165	143	158	99
1926							
January	159	229	160	165	143	156	98
February	156	225	....	164	143	156	99
May	153	226	....	160	139	161	105
June	153	226	....	159	138	161	105
July	152	....	... .	....	....	155	102

A FOOD SURVEY OF LIMA

B. A. WALLACE

What are the food requirements of Ohio cities and what part of these is produced locally? Are there demands in Ohio cities which nearby farmers could more fully supply to the advantage of all concerned? With these questions in mind we made a food survey of the city of Lima and vicinity in 1924. Lima was selected as a typical western Ohio city.

The method of study was to secure from all transportation agencies a record of the food products shipped into and out of the city. By this method the annual per capita consumption of food stuff in Lima was found to be as follows:

TABLE 1.—Per Capita Food Consumption of Several Products in Lima, Ohio

Vegetables	Pounds	Fruits	Pounds
Asparagus	0.3	Apples	55.9
Beans	16.2	Bananas	17.0
Beets	1.6	Grape fruit	5.8
Cauliflower	.7	Grapes	10.2
Carrots	1.8	Lemons	3.6
Corn—canned	3.0	Oranges	25.2
Celery	7.4	Peaches—fresh	34.0
Cabbage	25.9	Peaches—canned	3.5
Lettuce	8.7	Pineapple	2.9
Onions	15.8	Strawberries	18.1
Peas—canned	2.4	Cantaloupes	5.0
Potatoes	170.4	Watermelons	16.1
Sweet potatoes	6.5	Cherries—canned	1.8
Spinach	1.5	Dried fruits	5.0
Tomatoes—canned	6.7		
Miscellaneous		**Miscellaneous**	
Pork	94.8	Milk—Fluid	232.9
Beef	60.1	—Condensed	33.1
Veal	9.0	—For ice cream	47.3
Mutton	1.4	—For sweet cream	18.9
Dressed poultry	9.4	Cheese	8.5
Lard substitute	4.5	Butter—Creamery	35.8
Eggs ......dozen	27.0	—Dairy, estimated	7.0
Flour	156.0	Oleomargarine	20.0

Table 1 includes only farm commodities that can be produced locally, or that, compete in a measure with local products, as oranges and bananas which reduce the use of apples or strawberries. The exact amounts brought to the city direct from the farm were difficult to get; and the consumption of dairy butter, eggs, beets, and spinach, had in part to be estimated. In spite of these estimates, the figures check surprisingly well with consumption data from other sources.

To what extent are these commodities produced locally? To what extent must they be imported? In this study local produc-

ORCHARD TREES NEED NITROGEN

WEEKLY PRESS BULLETIN

F. P. Cullinan, horticulturist at the Indiana Experiment Station, was the principal speaker on the Ohio orchard day program at the Ohio Station. He said, "Lack of available nitrogen and of moisture are limiting factors in fruit tree growth and production".

"This is shown by the experience of growers and the results of investigators. The work of J. H. Gourley while at the New Hamphire Station, showing reduction of nitrates under grass; the response secured by F. H. Ballou from the use of nitrate fertilizers in southeastern Ohio; the success secured with various mulches by Stewart in Pennsylvania, all suggest the importance of an orchard soil management that will conserve the moisture and nitrate supply.

"Nitrogen in the soil is essential for increasing growth, influencing fruit bud formation, and fruit setting. Moisture is important for increasing growth of trees and size of fruit.

"During the first ten years of an experiment in southeastern Indiana, started in 1910, trees under the tillage-cover-crop system made the greatest growth and were more productive than trees in grass mulch. Trees receiving an application of straw as mulch each year were as large and nearly as productive as trees receiving tillage.

"Nitrate of soda was applied in 1921 to the trees in a portion of each plot at the rate of 5 pounds per tree. The trees under cultivation with a cover crop were not benefitted. Later these trees are beginning to show the need of nitrogen in addition to that supplied by the soil.

"Trees under straw mulch were about as productive as those under tillage. Trees in the grass-mulch plots were greatly benefitted by the application of nitrogen. An all-over application of nitrate of soda and acid phosphate between the trees increased the growth of grass to be used for mulch. This heavy mulch smothered out the grass under the trees and caused the trees to make nearly as good growth as those under cultivation."

FEEDING DAIRY COWS

WEEKLY PRESS BULLETIN

Feeding dairy cows on pasture not only increases their production but enables them to store up reserve material which has an important influence upon their production even during the following lactation period.

This has been shown by experiments, says A. E. Perkins of the dairy department at the Ohio Experiment Station, altho the proportion of protein in the grain mixture necessary for best results is still an unsettled point among authorities on feeding. It is generally recognized that the immature grass of a good pasture contains more protein than hay and other roughages of stall feeding. For this reason less protein is required in the grain mixture fed to cows on pasture.

Feed mixtures recommended for milk cows on pasture range from a mixture consisting wholly of corn, oats, and wheat bran with a protein content of 12 percent to a mixture of at least one-third high protein product giving a total protein content of at least 20 percent.

An experiment comparing grain mixtures containing 12 percent and 20 percent protein is now under way at the Ohio Station. So many factors are involved, it was explained, that it may be necessary to continue the test several seasons before definite conclusions can be announced.

The Bimonthly Bulletin

Vol. XI, No. 6 Nov.-Dec., 1926 Whole No. 123

Ohio Agricultural Experiment Station

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OHIO AGRICULTURAL EXPERIMENT STATION
Wooster, Ohio, U. S. A.

Number 70, left, Holstein-Friesian Registry No. 242861. Semi-official yearly test 17,485 pounds milk containing 662 pounds of butterfat.

Number 59, right, Holstein-Friesian Registry No. 248372, a three-fourths sister to No. 70 used in a long-time experiment on a monotonous, unpalatable ration, best record under these conditions 9,138 pounds milk containing 285 pounds of butterfat.

Number 119, American Jersey Cattle Club Registry No. 321888, semi-official yearly test 10,768 pounds milk containing 614 pounds of butterfat.

Number 122, American Jersey Cattle Club Registry No. 321,889, best record, as 3-year-old, 4,072 pounds milk containing 201 pounds butter-fat.

Number 59 doubtless would have produced as well as her sister under like conditions. Many cows are denied the feed which will permit them to produce liberally.

Altho Cow 122, lower right, was not fed as liberally as 119, lower left, she stayed fat all the time but failed to produce nearly as well as other cows receiving the same ration. She is a typically unprofitable cow.

BIMONTHLY BULLETIN

OF THE

Ohio Agricultural Experiment Station

VOL. XI, No. 6 NOVEMBER-DECEMBER, 1926 WHOLE No. 123

LIBERALITY AND ECONOMY IN FEEDING DAIRY COWS

A. E. PERKINS

That feed cost represents more than half the total cost of milk production has been shown by careful studies in the leading dairy districts of the United States. The proportion of feed cost to total cost is lowest where use is made of good pastures. It reaches nearly 60 percent of the total cost during the period of exclusive stall feeding and under conditions where there is little or no pasture. It is imperative, therefore, that feed be used efficiently, if milk production is to be economical.

Economical use of feed in dairying has, however, a vastly different meaning than might at first appear. The maintenance requirements of different cows of the same size agree quite closely; and so far as feed is concerned, maintenance is the chief overhead expense. Eckles, at the Missouri Experiment Station, has shown that the chief point of difference between good and poor producers is their relative ability to use feed in excess of maintenance.

Given the best of cows and the best of management, the maintenance requirement, or "feed overhead", absorbs quite a large percentage of the feed supplied. When cows are being kept that are unable to make good use of large amounts of feed beyond maintenance needs, or, when cows which do have this ability are denied as much feed as they can use to advantage, the maintenance requirement, or non-productive part of the ration, becomes an unduly large percentage of the total ration supplied, resulting in an extravagant use of feed.

Scant feeding may be intentional or it may result from the all-to-common practice of feeding all the herd alike regardless of production or stage of lactation. By such a system of uniform feeding, the cows are likely to be underfed in early lactation when heavy

production is natural and can be most easily obtained by liberal feeding. To underfeed a cow at this time is most wasteful. In the uniform feeding of the entire herd, cows which are underfed in early lactation and not permitted to make their best production are likely to be overfed near the close of lactation when they are unable to use the extra feed to good advantage, thus resulting in further extravagance.

A study reported in this publication in October, 1917, based on records secured in the herds of thirty-three Ohio farmers, showed that in these herds three times as much feed above maintenance was being used to produce a unit of milk or fat during the tenth month of lactation as during the first month. This illustrates the folly of light feeding in early lactation and of over feeding in late lactation.

A principle called "The law of increasing and diminishing returns," has long been spoken of as applying to animal feeding. According to this principle an animal will return more for each additional unit of feed up to a certain amount, above which the return for each additional unit of feed diminishes. The more liberal the feeding up to this point, the more efficient the ration; above this point, the more liberal the feeding the less efficient the ration becomes, according to this principle. The operation of this law is quite widely recognized, and with equal propriety may be invoked against either excessively heavy or light feeding. This law has been freely used as an argument against the heavy feeding of dairy cows. It has never been clearly stated, however, at just what level of feeding and production the return for additional units of feed ceases to increase.

Data collected by the Ohio Experiment Station regarding the feed supplied and the product returned by the thirty cows of the Station herd which have been given the semi-official yearly test for productive ability furnish some definite evidence touching this point. A comparison of the feed and the production of these cows when on the liberal feeding of the official test period has been made with the corresponding feed and production of the same cows in other lactation periods when their ration was such as is supplied regularly to the remainder of the herd.

The ration ordinarily supplied these cows was probably better than the usual farm ration. On this ordinary feeding, the average production was 8,193 pounds milk and 332 pounds fat, which is more than double the average production for Ohio cows according to the U. S. Census.

Even with these cows, seemingly already so well fed, an increase of about 50 percent in the amount of feed supplied during the test period increased the production to 13,588 pounds of milk and 557 pounds of fat, or more than 60 percent—a production nearly four times the Ohio average. Considering only the *amount* of feed, the higher production of the test period was apparently still the more economical, altho it must be admitted that the *quality* of feed, which can not well be expressed in figures, was doubtless in favor of the test periods.

The Trumbull County Experiment Farm in 1924 began better management and better and more liberal feeding of the dairy herd. Ten cows of this herd during the first 10 months of the succeeding lactation period made an average increase in production of 2,426 pounds of milk, containing 69.6 pounds of butterfat. About $16 per cow was the value of the additional feed consumed, each dollar of which returned three dollars worth of extra product.

The Purdue (Indiana) Experiment Station reports an experiment in which several cows were observed for a year under the owner's care. The following year these cows were fed as a part of the experiment station herd. The value of the feed per cow was increased from $43.72 to $72.34. Under the improved feeding the value of the product increased from $121.36 to $207.38. The increased value of the product was in this case also more than three times the increase in value of the feed.

Will similar increases in feed under ordinary farm conditions always result in such large increases in production as reported in the above comparisons?

To answer this question the Ohio Station has feed and production records for 1,134 cows in the herds of thirty-three representative farmers in various parts of the State. These records which were obtained about ten years ago, and published in Bulletin 334, have been arranged for our present purpose according to the liberality of feeding, as repored by the cooperating farmers. They were then divided into three groups of eleven herds each. Because of the wide variety of feeds employed, a modification of the Scandinavian Feed Unit system has been used to reach a common basis of comparison.

In our present use of this system one pound of any kind of grain is considered as a feed-unit. Two pounds of hay, four pounds of either straw or corn stover, and six pounds of corn silage are each valued as one feed-unit.

The average number of feed units in addition to pasture supplied yearly per cow in group 1 was, in round numbers, 4,400; group 2, 3,400; and group 3, 2,600. The average difference in feeding between the herds in group 1 and those in group 3 was 1800 units. This 70 percent increase in amount of feed caused only a 24 percent increase in production, which was not a paying proposition.

In the first three examples cited, even at the high level of feeding and production maintained in those experiments, the point in liberal feeding above which the return for each additional unit of feed decreases had not been reached.

A study of the data from the thirty-three farm herds of the last example would lead to the belief that the point of diminishing returns had already been passed altho these cows were fed much less liberally than those mentioned in the other three cases. In the first three instances in which the results clearly indicate the superior economy of heavy feeding, we are dealing with selected cows capable of liberal production. These cows, it would seem, had not previously been worked to capacity.

The three principal points of superiority for the treatment accorded the high producing groups doubtless were:

(1) Feeds of the best obtainable quality were provided.
(2) An adequate quantity of feed determined by production was supplied in the early part of the milking period.
(3) Hay and grain were supplied freely as needed to assure an abundance of feed to the cows while on pasture.

The thirty-three herds furnishing the data in the last example were probably above the average for the State in both quality of cows and feeding practices. The average production was 5,884 pounds milk and 255 pounds of butterfat. Either a lack of capacity for liberal production on the part of these cows or less judicious feeding must have prevented the favorable response to heavier feeding found to apply in the other cases cited.

The published records of cowtesting associations afford abundant evidence that the efficiency of a dairy herd can be decidedly increased by selection for productive ability and by feeding according to production. A constructive breeding program is also necessary if the progress is to be made permanent.

When these conditions are fulfilled there is little question that a degree of liberality of feeding far beyond what is ordinarily practiced will richly repay the dairyman for the extra thought, care, and capital expended. This is the direction in which the dairyman may look for greatest progress.

There is some indication that heavy, forced feeding, if practiced continuously, may predispose animals to abortion and sterility, altho such troubles are by no means always present among heavy-fed cows, nor wanting among cows as ordinarily fed. Aside from this possibility and the somewhat greater tendency to periods of digestive disorder, requiring more watchfulness on the part of the feeder, the cows usually suffer no inconvenience from such periods of intensive work.

The essential features of a liberal tho economical feeding program may be summarized as follows:

1. The cows must be selected for productive ability. Overfeeding of cows that are unable to produce liberal quantities of milk can never be profitable.

2. The selected cows that are capable of liberal production must be fed at all times with reference to their needs, which vary to a marked degree with the stage of lactation and the amount of production. The actual feed requirement of a liberally producing cow may be three or four times as much during heavy production as near the close of lactation; and the feeding system must be elastic enough to take account of such changes in feed requirement.

3. Since the cow can not possibly eat three or four times as much of the same feeds that would ordinarily comprise her ration at a low level of production, a large proportion of well selected concentrates or grain feeds must be employed.

4. Tho fed heavily with concentrates, the cow must also be encouraged to eat a liberal supply of roughages, and preferably also she should have a succulent feed of some kind which will stimulate her appetite and help to keep her digestive organs in good working condition.

5. Clover, alfalfa, or soybean hay fed in connection with corn silage, roots, or pasture, makes one of the best combinations for the roughage part of the ration.

6. Quality, palatability, and the individual preferences of the animal for different feeds, especially hay, are points which should receive more consideration than is commonly given to them.

7. Supplementary feeding of grain, even with good pasture, is necessary if heavy producing cows are to continue at a high rate of production. Good hay or silage, or both, may also be provided to advantage as the pasture fails.

8. Care must be taken not to overfeed to the point of disturbing the cow's digestion. This will usually result in a decided loss in

production. Ordinarily, feed should be supplied to support the production already being made, and not in the hope of forcing the cow to new heights of production.

9. We favor a grain ration of medium protein content, rather than one extremely high in protein, as being less expensive and also less likely to cause trouble with the cow. One pound of grain to three pounds of milk produced is a familiar rule for gaging the amount of grain to be fed, but this proportion of grain to milk can well be exceeded in many cases according to our observations. The heavily fed cows of the Experiment Station herd received at times as much as one pound of grain to two pounds of milk, when the milk was of high fat content.

10. It has come to be considered desirable, if not essential, to supply the mineral elements, calcium and phosphorus, to high producing cows in quantities greater than those contained in the usual feeds. Bone meal prepared for feeding, or equal quantities of bone product and finely powdered limestone, fed to the extent of about 4 ounces daily in connection with the grain or the customary allowance of salt, are he best known sources of the needed elements.

The average annual production per cow in Ohio as reported by the U. S. Census is 3,603 pounds of milk. Cows that will produce five or six times this amount of milk, or its equivalent in richer milk, under proper care and feeding, are not uncommon in any of the leading dairy breeds. Practically all the investigations of the cost of production have shown that milk costs much more in low producing herds than in herds producing more liberally.

No man can hope for success in dairying while his herd is making only Census average production.

Work of the cow testing associations has shown that most herds contain some cows capable of greater production than is permitted by their feeding.

The three equally important steps to real economy in the use of dairy feeds and to consequent economy of production are: First, the elimination of drones (those cows incapable of liberal production); Second, the building up of herds which are capable of liberal production; and, Third, the liberal feeding of these cows. Parsimony and economy may be synonymous in the minds of many; but in dairy feeding, true economy is more closely related to liberality.

FATTENING STEER CALVES

CORN AND OILMEAL IN DRY-LOT RATIONS, PREVIOUS TO FEEDING ON GRASS

G. BOHSTEDT

The cattle-feeding program during last winter was much the same as during the previous winter, except that steer calves instead of heifer calves were used. In both instances the cattle came from the Highland Hereford ranches of south-western Texas. The steer calves were not as uniform in type and weights as the heifer calves the year before.

The calves were purchased at Kansas City on December 10, 1925, weighing 348 pounds, and costing $8.90 laid down at Wooster. They were fed a ration of corn silage, mixed hay, corn stover, and linseed meal, for about one month, or until January 12, 1926, when they averaged in weight 379 pounds, costing $8.78 per 100 pounds. At this time they were divided into four comparable lots of ten calves each.

May corn be reduced or eliminated?—For several seasons this question, put to older cattle at the Station, has usually been answered to the effect that liberal feeding of corn is more profitable than decreasing it in or eliminating it from the ration. This does not mean that cattle feeding has been profitable each season, but that the heavily-corn-fed steers either showed larger profits or smaller losses than steers fed little or no corn with a ration of legume or mixed hay, corn silage, and linseed meal. There is no reason to suppose that calves, which are becoming more and more popular, should behave differently in this respect. However, the question is often asked, how calves might be expected to fatten on first class alfalfa hay and corn silage with a minimum of concentrates.

How will the rations prepare calves for pasture feeding?—A year ago it was found necessary to omit the summer pasture feeding of the calves that during the winter had been fed rations similar to those fed this season. These dry-lot rations varied from one made up entirely of roughages to one containing corn and oilmeal in addition to roughages.

All feeds were full-fed except the oilmeal which was fed to the extent of two pounds daily per calf in Lots 2, 3, and 4.

Dry-lot rations:

Lot 1—Alfalfa hay, corn silage.

Lot 2—Oilmeal, alfalfa hay, corn silage.

Lot 3—Shelled corn last 13 weeks, oilmeal, alfalfa hay, corn silage.

Lot 4—Shelled corn, oilmeal, alfalfa hay, corn silage.

The first two rations, especially that of Lot 1, may be considered stocker rations. Those of Lots 3 and 4 certainly are fattening rations, which when fed thru the winter would make subsequent pasturing seem unwise. Fully aware of the probable results on pasture, the Department of Animal Industry nevertheless decided to place even these nearly finished steers on grass. It seems as if too many cattle feeders who in late spring run low on hay, silage, or shock corn, and still are not ready to ship the cattle, are tempted to turn heavily-corn-fed steers on grass. What limited data there are, show that no gains are made during the first months on grass, even tho heavy corn feeding is continued during this time. It was, therefore, for the purpose of having a striking example that profits on the corn-fed steer calves would be sacrificed that these were turned on blue grass, on June 22. All four lots on grass were fed ground corn and oilmeal.

Pasture feeding:

Ground corn, full-fed.

Oilmeal, one pound daily per calf until August 25, two pounds thereafter.

Dry-lot results.—During the feeding period of 161 days, January 12 to June 22, as shown by Table 1, the hay and silage-fed calves of Lot 1 gained 1.37 pounds daily. With two pounds oilmeal added to that ration, Lot 2 gained one-half pound more, or 1.87 pounds daily. This was a very similar showing to that of a year ago. Lot 3, fed corn during the last 13 weeks, otherwise fed the same as Lot 2, gained 2.07 pounds daily per head; and Lot 4, full-fed corn from start to finish, together with oilmeal and hay and silage, gained 2.12 pounds daily per head. These gains are in every case noticeably smaller than those of the heifer calves on the corresponding rations the previous year.* Figure 1 shows the four lots of steer calves at the end of the dry-lot feeding period.

On the basis of the prevailing Cincinnati market price for such cattle in June, Lot 1 was valued at $8.75; Lot 2, $9.25; Lot 3, $9.50; and Lot 4, $9.75. Valuations were placed on the first two lots even tho they were not in market condition, not having been fed with the

*See Ohio Agr. Exp. Sta., Bimonthly Bul., Nov.-Dec., 1925.

Fig. 1.—The four lots of steer calves at the end of the winter dry-lot feeding period, June 22, just before they were turned on grass. From top to bottom there is apparent a marked increase in degree of fatness.

market in mind until after a summer pasture feeding period. Lots 3 and 4, due to the relatively modest gains and consequent market valuations, returned correspondingly moderate profits over feed costs, $2.00 and $3.06 per head, respectively. Nevertheless this was the time they should have been sold rather than after a period of pasture feeding. Their dry-lot ration had been relatively concentrated, resulting in a deposition of fat in these cattle, and no doubt a smaller alimentary capacity. Pasture is very bulky, but palatable, and cuts down the appetite, as well as room in the digestive tract, for corn. Since their net energy intake is cut down considerably, such steers on grass make poor gains for many weeks.

TABLE 1.—FATTENING STEER CALVES

May Corn or Oil Meal Profitably be Reduced or Eliminated When Alfalfa Hay and Corn Silage Are Fed in the Ration? What Is the Relative Merit of Such Rations for Dry-lot Feeding, or as Preparation for Pasture Feeding?

Rations in dry lot	Lot 1 Alfalfa hay, Corn silage	Lot 2 Oilmeal, Alfalfa hay, Corn silage	Lot 3 Corn, after March 23, Oilmeal, Alfalfa hay, Corn silage	Lot 4 Corn, Oilmeal, Alfalfa hay, Corn silage
Dry-lot feeding period, January 12 to June 22, 1926—161 days				
Number of steers per lot	10	10	10	10
Number of hogs following*	None	None	5	5
Cost of steers at start of experiment	$8.78	$8.78	$8.78	$8.78
Weight of steers at start of experiment, January 12	378	380	380	378
Weight of steers at end of dry-lot experiment, June 22	599	681	713	719
Average daily gain for 161 days	**1.37**	**1 87**	**2.07**	**2.12**
Average ration:				
Shelled corn	.4†	.4†	4.5	7.3
Linseed meal	....	2.0	2.0	2.0
Alfalfa hay	4.6	3.2	2.2	1.5
Corn silage	20.3	23.8	15.8	8.9
Feed required for 100 pounds gain:				
Shelled corn	28†	20†	215	344
Linseed meal	....	107	97	94
Alfalfa hay	334	169	109	70
Corn silage	1,480	1,273	762	422
Cost of 100 pounds gain‡	**$7.08**	**$7.76**	**$8.12**	**$8.47**
Necessary selling price at Wooster to break even	$8.15	$8.33	$8.32	$8.42
Estimated selling price at Wooster (Cincinnati market value minus $.90)	$7.85	$8.35	$8.60	$8.85
Estimated selling price at Cincinnati	**$8.75**	**$9.25**	**$9.50**	**$9.75**
Estimated returns per steer at feed costs:				
Excluding hogs	—1.82	.15	.90	1.56
Crediting hog profits§	—1.82	.15	5.26	8.49
Crediting feed saved by hogs	**—1.82**	**.15**	**2.00**	**3.06**
Pasture feeding period, June 22 to September 14, 1926—84 days**				
Weight of steers at start of period, June 22	599	681	713	719
Weight of steers at end of period, September 14	734	778	794	795
Average daily gain for 84 days	**1.60**	**1.16**	**.97**	**.91**
Average ration:				
Ground corn	10.5	9.6	9.9	9.5
Linseed meal	1.2	1.2	1.2	1.2
Feed for 100 pounds gain:				
Ground corn	657	826	1,028	1,044
Linseed meal	77	106	127	137
Cost of 100 pounds gain‡	**$10.93**	**$11.24**	**$17.27**	**$17.75**

TABLE 1.—FATTENING STEER CALVES—Continued

Rations in dry lot	Lot 1 Alfalfa hay, Corn silage	Lot 2 Oilmeal, Alfalfa hay, Corn silage	Lot 3 Corn, after March 23, Oilmeal, Alfalfa hay, Corn silage	Lot 4 Corn, Oimeal, Alfalfa hay, Corn silage
Combined dry-lot and pasture feeding, January 12 to September 14, 1926—245 days				
Weight of steers at start of experiment, Jan. 12	378	380	380	378
Weight of steers at end of experiment, Sept. 14	734	778	794	795
Average daily gain for 245 days	1.45	1.63	1.69	1.70
Average ration:				
Corn	3.9	3.6	6.3	8.0
Linseed meal	0.42	1 7	1.7	1.7
Alfalfa hay	3.0	2.1	1.5	1.0
Corn silage	13.3	15.6	10.4	5.9
Feed required for 100 pounds gain:				
Corn	266	218	375	472
Linseed meal	29	107	103	102
Alfalfa hay	207	127	87	57
Corn silage	919	961	613	345
Cost of 100 pounds gain‡	$8.54	$9.29	$9.92	$10.16
Necessary selling price at Wooster to break even (Pasture charge included**)	$8.87	$9.23	$9.42	$9.51
Selling price at Wooster (Cincinnati market value minus $.90)	$8.10	$8.60	$8.85	$9.10
Selling price at Cincinnati	$9.00	$9.50	$9.75	$10.00
Returns over feed costs: (Pasture charge included**)				
Excluding hogs	−$5.63	−$4.93	−$5.65	−$4.73
Crediting hog profits§	−$5.63	−$4.93	$1.30	$2.21
Crediting feed saved by hogs	−$5.63	−$4.93	−$4.56	−$3.22

*Hogs were following the steer calves only while these were fed shelled corn, i. e., January 12 to June 1, for Lot 4, and March 23 to June 1, for Lot 3.

†From June 1 to June 22 the steers of Lots 1 and 2, as well as 3 and 4, were started on ground corn, preparing them for pasture feeding.

‡Feed prices: Shelled corn $.70, ground corn $.76 per bu.; linseed meal $52; alfalfa hay $18; corn silage $5; tankage (fed to hogs) $70 per ton. Hogs were valued at $13.50 per 100 pounds.

§No hogs in Lots 1 and 2.

**Pasture was charged at $6 per acre for a 5½ months grazing season. It is estimated that each calf used one-half acre for one-half of the grazing season, resulting in a charge of $1.50 per head.

Summarizing the dry-lot feeding period, as in previous experiments, the more corn fed in the ration, the greater the returns over feed costs.

Pasture feeding results.—On June 22 all four lots were turned on grass and fed alike, but each lot to itself, a full feed of ground corn and a limited amount of oilmeal. Figure 2 shows the calves on blue grass pasture, which is seen to include considerable woods. The pasture did not become parched during the summer but

remained rather green. Until July 20 the steers were out on pasture in the day time; after that, when the flies became more bothersome, they were kept out at night. They were fed the grain in the barn mornings and evenings.

Fig. 2.—The forty steer calves on pasture, August 23. While all are grazing together on pasture, in the barn each lot of ten was fed grain by itself.

Chart 1 shows that all lots of steer calves lost weight immediately after being turned on grass, but that the corn-fed calves lost much more and required a longer time to regain the weight they had lost. Thus Lot 1 lost 10.2 pounds per head during the two weeks from June 22 to July 6 and was back at its original weight in 18 days. Lot 4 on the other hand lost 37 pounds per head during the same two weeks and did not regain the lost weight short of 29 days from the time they were turned on grass. Meanwhile both lots as well as Lots 2 and 3 consumed what grain they cared for, amounting to from 5 to 6 pounds ground corn and 1 pound oil meal, after August 25, 2 pounds oilmeal, daily per head. This was, to be sure, only about two-thirds as much corn as the corn-fed calves of Lots 3 and 4 had consumed during the month previous to June 22. Being turned on grass constituted a violent change, especially for the corn-fed cattle, and required weeks for readjustment. The lesson is plain. Corn-fed cattle would much better have been sold directly out of the dry lot.

Shipping and slaughter.—The four lots of steers were shipped on September 18 to the Cincinnati stock yards. The night before shipping they were kept in the barn and fed mixed hay. Only one-half as much grain as usual was allowed for the last two feedings.

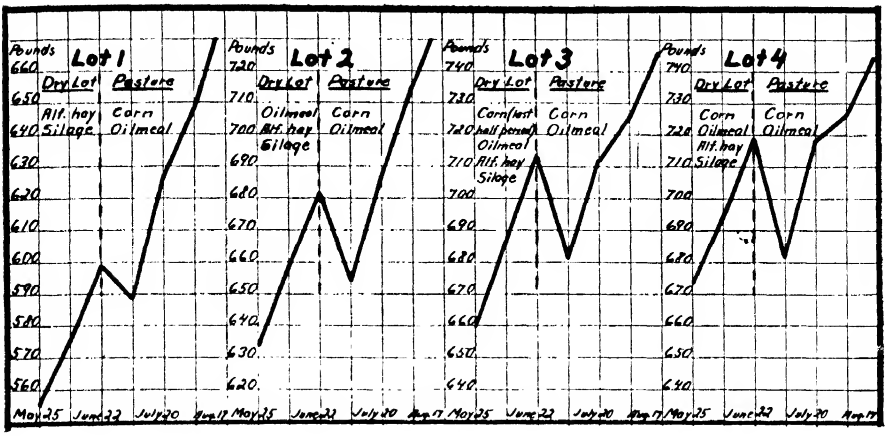


Chart 1.—The fatter the cattle were when turned on grass, the more weight they lost and the longer it took to come back to the original weight. The chart shows only the last four weeks of the dry-lot period and the first eight weeks of the pasture period.

Table 2 presents the shipping and slaughter data, including the weights on the last day of the experiment, the day of loading, the day of arrival at the stock yards, and the dressed weights. In spite of the excessive delay in transit, the cattle came thru with a relatively light shrink, which was to be credited in large part to the method of feeding previous to shipment. The shrink was fairly comparable for all lots.

TABLE 2.—SHIPPING AND SLAUGHTER DATA

	Lot 1	Lot 2	Lot 3	Lot 4
Average weight at end of experiment, Sept. 14, pounds	734	778	794	795
Average weight just previous to loading, Sept. 18, pounds	720	767	786	784
Average weight at Cincinnati, Sept. 21, pounds	706	750	766	763
Shrinkage based on last experimental weight, percent	3.81	3.60	3.53	4.03
Shrinkage based on weight before loading, percent	1.94	2.22	2.54	2.68
Average dressed weight, warm, pounds	409.9	444.9	435.4*	451.2
Dressed yield, warm, percent	58.1	59.3	56.8*	59.1
Price, live weight, at Cincinnati	$9.00	$9.50	$9.75	$10.00
Price per pound dressed meat, warm weight	$0.155	$0.16	$0.172	$ 0.169

*No explanation can be had for the relatively low dressed yield of Lot 3.

Observations on the carcasses in the cooler showed them to be of a very good color in spite of the pasture feeding. They had on the whole an even covering of fat, but little surplus fat. There

was relatively little kidney fat. While far from being prime in condition, the carcasses were, because of little waste, rated very desirable for the butcher trade of Cincinnati.

In the opinion of a Cincinnati market expert the corn-fed lots at the end of the dry-lot feeding period, in June, were at that time more desirable for the packer buyer than they were after three more months of feeding corn on pasture. It is possible that the small gains on pasture were more a matter of growth than fattening.

Financial returns.—It did not pay in this experiment to turn any of the steer calves on grass, no matter what ration they had previously been fed. Returns over feed costs for the fattening rations were low after the winter and spring feeding period. Valued at prevailing June market prices, Lot 3, fed shelled corn for the last 13 weeks, returned $2.00 per head over feed costs, and Lot 4, fed the more ideal fattening ration, $3.06.

Returns for all lots were depressed into the loss column after the summer pasture feeding period. Lots 3 and 4, since June 22, occasioned a relatively greater reversal of profitableness than the other two lots, even tho as the end result they showed a smaller loss, as follows: Lot 1, $5.63; Lot 2, $4.93; Lot 3, $4.56; and Lot 4, $3.22. These returns, or losses, are computed on the basis of crediting back to the steers the feed that was saved by the hogs that were following the steers. The hogs were fed daily .3 pound tankage each and just enough corn to make them clean up well in the feed lot. Pasture during the summer was charged at $6 per acre. It was estimated that each calf used a half acre during the time it was on grass.

SUMMARY

The more corn fed to steer calves during the winter and spring dry-lot feeding period, the greater the returns over the cost of the ration.

When turned on grass, in June, the calves lost weight during the next two weeks in proportion to the amount of corn, or concentrates, which they had been fed previously.

It likewise took the fatter, corn-fed steers longer to regain the lost weight. Twenty-nine days had passed before the heaviest corn-fed group was back at the original weight when turned on grass.

It, therefore, did not pay to turn on grass cattle that had been nearly finished for the market in dry lot.

STANCHION-FEEDING COMPARED WITH GROUP-FEEDING OF BABY BEEVES

A STUDY OF CALF PSYCHOLOGY

G. BOHSTEDT

Will a beef calf eat more when crowding around a common "table," with other baby bovines as competitors, than when undisturbed in the possession of his own full "lunch basket"? This inquiry was directed more at the "social" instincts of calves than at the palatability or economy of any feed or ration.

Much individual feeding is done at the Ohio Experiment Station as well as at other institutions and breeding establishments where stock is fed experimentally or is fitted for show purposes. The problem of stanchion-feeding as compared with group-feeding is, therefore, interesting, making one speculate how much better a calf or pig or colt might eat and develop, if it had company at the feed trough. In the human family, the capacity of boys around a picnic table is usually anticipated and prepared for. Anything seems much more desirable if others are seen eager to obtain possession of it.

The story is told of some fat barrows that were intended to be shown at the fair, but had ceased to eat well and consequently failed to gain in weight as desired. Their appetites are said to have improved remarkably when several hungry "squealers" were placed in an adjoining pen. The sight and sound of slopping the fat barrows was most tantalizing to these thin pigs, whose squealing put the already prosperous pigs in a more appreciative mood.

The question of competition versus monopoly as a spur to feed consumption and gains in live weight was put to 20 calves and yearlings of the Aberdeen-Angus breed, that had been raised by the Experiment Station. Ten of these animals, three steers and seven heifers, were fed individually in stanchions, and ten others, also three steers and seven heifers, were fed as a group, around a common feed trough. They were started on feed February 23, 1926, and were fed until June 1, or 98 days. The grain mixture fed to both lots was ground corn 90 parts and linseed meal 10 parts. This mixture and alfalfa hay and corn silage were full-fed to both lots. On June 1 the lots were reversed, as to method of feeding, and continued for 105 days, or until September 14, when the data were summarized. The combined period was 203 days in length.

Figures 1 and 2 show the two lots as they looked on September 17, 1926, or 3 days after the close of the experiment. They did not present any marked differences in appearance, as might be expected since the two lots had on June 1 been changed about on the two systems of feeding. This reversal method was intended to eliminate as nearly as possible the factor of individuality of the animals.

Fig. 1.—They appreciated competition at meal time

Lot 1, at close of experiment, full-fed individually, in stanchions, during the first 98 days of the experiment, and as a group the last 105 days. They did not do as well as when fed individually as when fed together.

Chart 1 presents the growth curves of the two groups ot cattle on the respective systems of feeding. It is seen that in both periods the group-fed cattle (solid lines) forged ahead of the stanchion-fed cattle (broken lines). The chart also indicates that at the beginning of the second period it took the cattle of Lot 2 longer to adjust themselves to stanchion-feeding than it took those of Lot 1 to adjust themselves to group-feeding.

Fig. 2.—These also did better under conditions of rivalry

Lot 2, very much like the first group, with which they alternated, also had better appetites when crowding around a common feed trough, and made better gains than when each had an abundance of feed given separately in a manger.

Table 1 shows that in the first period the stanchion-fed calves gained 2.38 pounds daily per calf and the group-fed calves 2.66 pounds, therefore .28 pound more per day, or 27.5 pounds more during the 98 days. In the second period the difference was even greater in favor of group-feeding, or 60.6 pounds, making a total gain of 88.1 pounds more per calf for group-feeding than stanchion-feeding during 203 days.

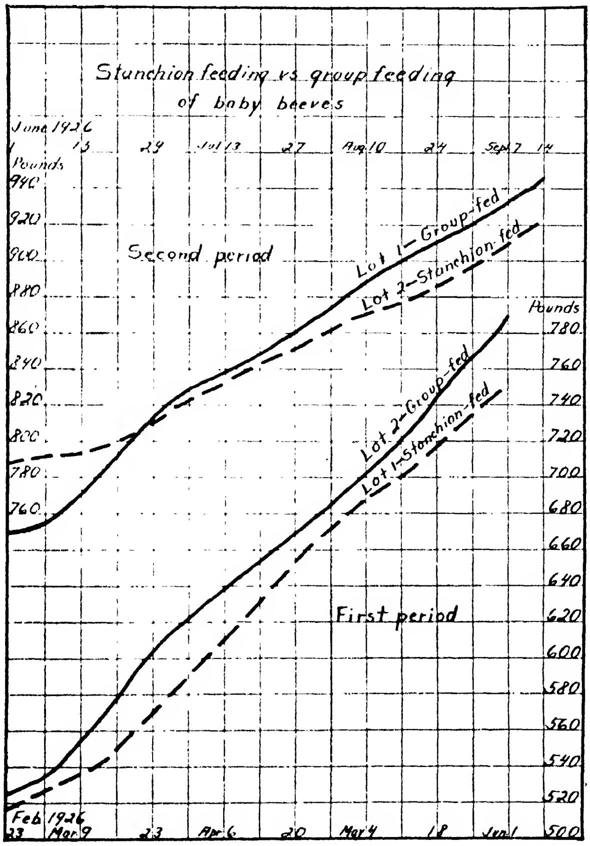


Chart 1.—Relative gains of baby beeves when fed as a group contrasted with others fed individually in stanchions. Each line represents the average growth curve of ten animals.

The reason for this is explained by the data in Table 1, where for the first 98 days each "competing" calf daily ate .41 pound more grain, .95 pound more hay, and 2.18 pounds more silage than a "monopoly" or stanchion-fed calf. The differences during the second period were even greater. As an average for the combined

period of 203 days, each group-fed animal daily ate .90 pound more of the grain mixture, .27 pound more hay, and 2.85 pounds more silage than a stanchion-fed calf.

TABLE 1.—Stanchion Versus Group-Feeding of Baby Beeves February 13 to September 14, 1926—203 Days Ten Calves and Yearlings per Lot

	Stanchion-fed	Group-fed
First period, February 23 to June 1, 1926—98 days		
	Lot 1	Lot 2
Initial weight, pounds	518.7	526.6
Final weight, pounds	752.3	787.7
Average daily gain, pounds	**2.38**	**2.66**
Average daily feed, pounds:		
Ground corn*	7.90	8.28
Linseed meal	.87	.91
Alfalfa hay	2.45	3.40
Corn silage	13.61	15.79
Cost of 100 pounds gain†	**$7.45**	**$7.40**
Second period (reversal) June 1 to September 14, 1926—105 days		
	Lot 2	Lot 1
Initial weight, pounds	787.7	752.3
Final weight, pounds	921.4	946.6
Average daily gain, pounds	**1.27**	**1.85**
Average daily feed, pounds:		
Ground corn*	9.65	10.88
Linseed meal	1.01	1.14
Alfalfa hay	2.80	2.44
Corn silage	13.74	17.23
Cost of 100 pounds gain	**$16.21**	**$12.46**
Average of both periods, February 23 to September 14, 1926—203 days		
Initial weight, pounds	518.7	526.6
Final weight, pounds‡	886.0	982.0
Average daily gain, pounds	**1.81**	**2.24**
Average daily feed, pounds:		
Ground corn*	8.81	9.62
Linseed meal	.94	1.03
Alfalfa hay	2.63	2.90
Corn silage	13.68	16.53
Cost of 100 pounds gain	**$10.64**	**$9.56**

*Corn converted to 15.5 percent moisture basis.
†Prices of feeds: Corn $0.70 per bu.; linseed meal $52.00; alfalfa hay $18.00; and corn silage $5.00 per ton.
‡The total gain on each system of feeding was added to the initial weights on February 23, thus giving a merely computed rather than an actual final weight. It is remembered that the two lots were reversed at the end of 98 days.

The feeds were placed before the cattle in such amounts as to cali for daily weigh-backs of refuse. Care was taken to have the animals receive all the grain, to start with, and then the silage and hay they cared for. To show that especial care was taken to have the stanchion-fed cattle full-fed, the proportions of refuse to the total amounts offered are presented as follows: grain mixture 3.2 percent, alfalfa hay 24.4 percent, and corn silage 11.1 percent. The corresponding proportions of refuse for the group-fed cattle were:

grain mixture 1.2 percent, alfalfa hay 11.2 percent, and corn silage 4.0 percent. It was naturally easier to gauge the appetite of a group from day to day than that of each separate individual.

Cheapness of gain was in keeping with greater feed consumption and increased gain, in both periods favoring the side of heavier consumption. Little difference was observed in this respect during the first period, when the calves were fresh, and even individually-fed calves ate comparatively well. As they became fatter, in the second period, their appetites also became more fickle, resulting in more expensive gains for both groups, but relatively much more for the stanchion-fed cattle. On the average for the entire period, therefore, it cost $10.64 to put 100 pounds of gain on the stanchion-fed cattle and $9.56 on those fed as a bunch.

Summary.—Calves and yearlings around a common feed trough consumed more feed than corresponding cattle full-fed separately in stanchions.

In keeping with the increased consumption, the group-fed cattle made larger gains, and cheaper gains.

THE LITTER PROBLEM

D. C. KENNARD AND L. B. NETTLETON

Maintaining a supply of suitable litter has become a problem with many poultry keepers. Straw is most commonly used for scratching litter and as a floor covering will no doubt continue to be the most widely used; but in many localities straw is scarce and too high priced for economical use.

The all-mash method of feeding offers interesting possibilities for new sources of material, as the chickens no longer scratch in or eat from the litter or floor covering. Since, with the feeding of scratch grain, chickens also eat some of the litter and more or less of the filth which it contains, discretion must be exercised as to the kind of scratch litter used. If the chickens are not obliged to eat from the litter, other materials besides straw may serve as a floor covering. The ideal material is one that will not pack or cake, but will keep loose and act as an absorbent and yet not become dusty. No matter what is used it should be free from must or mould, otherwise serious loss may be expected.

Next to straw, perhaps, shavings are the best. They are not so subject to must or mould as straw, but for a scratching litter straw is preferable. For a floor covering, in connection with all-mash feeding, shavings are quite satisfactory. Often, however, they are not available in sufficient quantity, or the cost in bales is more or less prohibitive. There is some prejudice against shavings for small chicks, but they have been used quite extensively at the Station without any apparent ill effects.

It has been claimed that peat has advantages over other litter materials. Both the American and European products were tested at the Station poultry plant, but neither proved satisfactory.

The American peat was damp and musty upon arrival and later became very dusty. The tests were conducted with 100 White Leghorn pullets on a 20 by 20 foot floor space for each kind of litter. The pullets on American peat became so seriously afflicted with bronchitis and respiratory troubles that it had to be removed after four weeks. The result was a loss in egg production and a number of deaths, due to the musty litter. Must or mould in any kind of litter will cause serious trouble. A bale of musty straw will quickly check egg production and kill laying pullets.

In another test, imported peat moss was used. This was a much higher grade product and appeared to be free from must or odor of any kind. It was coarser and carried but little dust at first. After a few weeks the peat became rather dusty, and to overcome this condition it was lightly covered with straw. This aided considerably in keeping down the dust, as straw naturally attracts moisture. At the end of four months beginning with January, the peat moss had become so damp and filthy that it had to be removed.

The question of expense should be considered on this time basis. The directions for the use of peat moss for litter state that a bale should be spread over each 80 square feet of floor space, making a covering about three inches thick. For the 100 pullets on 400 square feet of floor, five bales at $3.50 per bale were required. The cost was $17.50. Renewal would be necessary at least three times during the year, which would entail an expense of $52.50 for 100 pullets, or a little over 50 cents per bird. Such an expense for litter is prohibitive. A poultry editorial writer recently stated that confined hens should have litter at least one foot deep and that peat moss makes an ideal litter. Evidently the writer did not consider the cost of peat litter one foot deep. To compensate for this high cost it is sometimes claimed that the litter can be sold after removal from the chicken house for as much as or more than it cost. This

may apply in some instances in truck growing sections but the average poultry keeper would likely find difficulty in making such disposal at more than a small fraction of the original cost.

Agricultural slag is a floor covering of promise in certain sections. A test of this material with 115 layers confined indoors on a 20- by 20-foot floor space for four months without renewal proved quite saticfactory. Every two weeks the droppings were raked off the surface and removed. Around the water stand an inch or so of the slag which became wet and caked was also removed.

Agricultural slag is different from other litter materials in that it does not become dusty even with continued use. This is a decided advantage. However, its dust-free property, being due to a certain attraction for moisture, may prove disadvantageous during the winter months as it may tend to make the poultry house more damp and cold. This is only assumption as no first-hand evidence has been secured on this point. But for spring, summer, and fall use there seems to be no question as to its value as a floor covering. Only dry material should be used during fall and winter months.

The slag may be spread 6 inches deep to serve for several months, or in smaller amounts if renewed oftener. Agricultural slag is permeated with sulfur and hydrogen sulphide and has a slightly alkaline reaction, all of which may serve to give it considerable disinfecting properties.

While slag was used for young chicks we are unable to draw any conclusion as to its merits in the brooder house. Until further evidence is secured we doubt whether it should be used for chicks under five or six weeks of age. Young chicks are inclined to eat freely of material of this kind, and eating an excess of it might prove harmful.

Altho our tests and experience with agricultural slag as a floor covering for poultry houses have not been of sufficient duration to warrant any definite conclusions, it appears to have some advantages for this purpose. There seems to be little question as to its being suitable to use for the layers during the spring, summer, and fall, especially if straw or shavings are not available or are expensive. The slag was used in connection with the all-mash method of feeding. It is doubtful whether it could be used to the same advantage when scratch grain is employed.

MEAT MEAL VERSUS MEAT SCRAPS FOR EGG PRODUCTION

D. C. KENNARD

Recently high (75 percent) protein meat meals have appeared on the market in addition to the 50 to 55 percent protein meat scraps commonly employed in poultry rations. To determine the relative merits of these products a preliminary test of one year's duration has been completed. Each group in the 12-month's test contained 30 Barred Rock pullets. The grain was composed of cracked yellow corn 2, wheat 2, and oats 1, fed in the litter to all lots alike. The mash consisted of equal parts of ground yellow corn, ground oats, wheat bran, and winter wheat middlings. The mash and scratch grain with green feed, oyster shells, and grit constituted the basal ration of all lots, to which was added the meat meal or the meat scraps.

TABLE 1.—Egg Production and Mortality in Meat-Meal vs. Meat-Scrap Test

Ration	Egg production	Mortality
	Number	*Percent*
Basal ration plus 20 percent meat and bone meal (50 percent protein)...	150	10
Basal ration plus 13.3 percent meat meal (75 percent protein)........ ...	132	10
Basal ration plus 13.3 percent meat meal (75 percent protein) and 2 percent mineral mixture	144	13.3

Mineral mixture:

Raw bone meal	60
Ground limestone	20
Salt	20

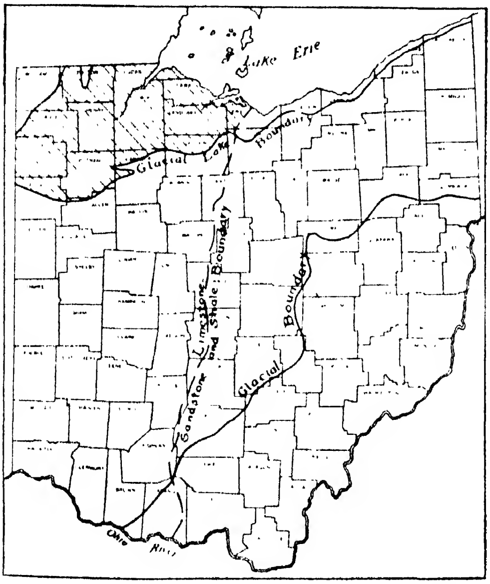
While other tests are necessary before conclusions would be warranted, these results indicate no advantages of the high protein meat meal over the lower protein product usually employed. The meat and bone meal (50 percent protein meat scraps) serves as a double supplement of protein and minerals; whereas the meat meal (75 percent protein) is essentially a protein product, and calls for a mineral addition to make it most effective. Since 50 to 55 percent meat scraps contains 20 to 30 percent mineral matter and the 75 percent protein meat meal contains but 5 to 10 percent minerals, the meat meal should be considered only as a protein supplement, requiring additional minerals to supplement the grain part of the ration. The results of the test support this contention.

THE SOILS OF THE GLACIAL REGION OF NORTHWESTERN OHIO

G. W. CONREY

The glacial lake plain in Ohio includes a narrow belt bordering Lake Erie in northern and northeastern Ohio and a broad area in northwestern Ohio extending to the state line in Paulding County. Here the area is about 2½ counties wide. The present discussion is confined to the area in northwestern Ohio west of central Erie County.

Origin of the soils.—Toward the close of the glacial period as the ice melted from Ohio the waters failing to find an outlet to the south began to accumulate in the area of which northern Ohio is now a part and formed a great lake extending as far west as Ft. Wayne, Ind. This lake existed for a sufficient length of time to form a gravelly beach ridge which marks its limit.



Area of glacial lake soils of northwestern Ohio

There were several stages in the recession of the waters from the highest lake stage to that of the present Lake Erie. This is shown by the presence of several beach ridges to which names have been given, each representing the extension of the lake during that particular stage. The stage of greatest extent is known as Lake Maumee, while Lake Whittlesey and Lake Warren are names applied to later stages.

While these lakes were in existence material was carried into them by the streams, just as is being done into Lake Erie today. This was assorted by the water and the coarse portion was left near the border of the lake as beach deposits, and other sandy near-shore deposits. The fine material was carried out into deeper water and dropped down as laminated silts and clays. However, over much of

SOILS OF THE GLACIAL LAKE REGION OF NORTHWESTERN OHIO

	Lacustrine soils								
Color of soil	Brown	Light yellowish-brown	Grayish-brown	Brownish-gray	Very dark gray (Sandy)	Very dark gray	Very dark gray	Gray-black to black	Dark gray to black
Color and	Reddish-brown	Yellowish-brown	Yellowish-brown slightly mottled	Mottled gray, yellowish-gray and yellow	Mottled yellowish-brown and gray	Mottled bluish-gray and yellowish-brown	Mottled bluish-gray and yellowish-brown	Mottled bluish-gray and yellow	Light gray
Character of subsoil	Stratified sand and gravel at 2 to 4 ft. Calcareous	Lower subsoil pale yellow Deep sand or sand and gravel Noncalcareous	Laminated silt and clay at 3 or 4 ft. Calcareous	Laminated silt and clay at 3 to 4 ft Calcareous	Lower subsoil calcareous clay loam or clay	Lower subsoil sand or sand and gravel	Lower subsoil heavy Calcareous		Marl
Topography	Beach ridges	Undulating	Gently rolling	Gently undulating	Level	Level	Level	Level	Level
Natural drainage	Good	Good	Fair to good	Fair to poor	Poor	Poor	Very poor	Very poor	Very poor
Series	**Fox, beach ridge phase**	**lainfield**	**Lucas**	**Fulton**	**Wauseon**	**Newton**	**Toledo**	**Maumee**	**Warners**
Important textures	Loam*	Fine sand	Silt loam silty clay loam	Silt loam silty clay loam	Fine sandy loam	Fine sand fine sandy loam	Loam silty clay	Fine sand loam	Loam

*Only types in northwestern Ohio are given in this table.

SOILS OF THE GLACIAL LAKE REGION OF NORTHWESTERN OHIO

	Deep glacial soils				Shallow glacial soils (over limestone)			Terrace soils second bottom	Flo d plain soils (first bottom)	
Color of soil	Brownish-gray	Brownish-gray to gray	Very dark gray	Gray-black	Brown	Brownish-gray	Dark gray to gray-black	Brown	Grayish-brown	Gray-black to black
Color and	Subsurface yellowish-brown slightly mottled with yellowish-gray	Mottled yellowish-brown and yellowish-gray	Mottled bluish-gray and yellowish-brown	Mottled bluish-gray and yellow	Reddish-brown	Mottled gray and yellowish-brown	Mottled bluish-gray and yellowish-brown	Reddish-brown	Light brown	Mottled bluish-gray and yellowish-brown
Character of subsoil	Upper subsoil dull yellowish-brown, heavy Calcareous below 24 to 30 in.	Upper subsoil very heavy Calcareous below 30 to 40 in.	Heavy	Heavy	Limestone at 20 to 36 inches	Limestone at 20 to 36 inches	Limestone at 30 to 36 inches	Stratified sand and gravel at 2 to 5 feet Calcareous		
Topography	Gently rolling	Undulating	Level	Level	Undulating	Undulating	Level	Level	Level	Level
Natural drainage	Fair	Poor	Very poor	Very poor	Good	Poor	Very poor	Good	Fair to good	Very poor
Series	**Miami**	**Napanee**	**Brookston**	**Clyde**	**Milton**	**Randolph**	**Millsdale**	**Fox**	**Genesee**	**Wabash**
Important textures	Loam* clay loam	Clay loam clay	Clay	Silty clay loam clay	Stony loam silt loam	Stony loam loam	Sto'y clay loam clay loam	Silt loam	Loam clay loam	Loam silty clay loam

*Only types in northwestern Ohio are given in this table.

the lake bottom there is very little evidence of such quiet water deposits. Rather the surface material is glacial drift deposited before the lakes covered the region, over which there is little or no mantle of lake deposits. Only locally, as west of Defiance and east of Toledo, are the fine texture lake deposits of considerable depth. Near the junction of the Maumee River and Maumee Bay a total thickness of 28 feet has been recorded, but this is exceptional. Such deposits are seldom over 10 or 15 feet in thickness.

Thruout much of the lake plain the surface material is glacial drift, as is evidenced by the presence of boulders and pebbles on and thruout the soil. A thin veneer of sandy material in the form of low knolls in places rests on the glacial drift, giving rise to numerous more or less isolated sandy areas. It is only adjacent to the old lake beaches that coarse lake deposits are at all extensive.

The character of the material carried into the lake is closely related to the nature of the surrounding uplands thru which the tributary streams flow. West of Sandusky the surface deposits are derived largely from limestone, whereas to the east the parent material is predominantly sandstone and shale. It is with the former region, largely of limestone derivation, that the present discussion is concerned.

Altho the glacial drift is derived chiefly from limestone material, there is a considerable admixture of shale, probably "Ohio shale", which accounts for the extremely heavy nature of the glacial deposits over this area in northwestern Ohio.

Into this lake plain streams have cut shallow valleys, which are the sites of alluvial deposits, some as first bottom lands, subject to overflow, some as second bottoms or terraces.

The soils of the region have resulted chiefly from the weathering of these lacustrine or lake-laid and glacial or ice-laid deposits. Deposited near the close of the glacial period, the time during which these materials could weather has been relatively short, hence the soils of the region are for the most part very young, as far as soil development is concerned. Moreover, the very wet, poorly drained condition of much of the region has tended to retard the normal processes of weathering and soil development.

Topography and drainage.—The most striking topographic features of the region are the old beach ridges which in places continue for miles as low ridges 150 to 200 yards wide and 20 to 40 feet above the adjacent lake-plain. These high lying areas, well drained because of their gravelly nature, were the sites for the first roads and houses in the region. Many of the leading highways of today follow these old beach ridges.

In contrast to these ridges is the level lake-plain which in places is almost floor like. Such flat areas exist in eastern Lucas and in Paulding County, altho taken as a whole the region would be considered very level. This level plain is broken here and there by low knolls and irregular ridges, which are usually sandy. Elsewhere low limestone ridges extend a few feet above the general level.

The level areas of the lake-plain were originally very poorly drained, in fact the "Great Black Swamp" existed over a large area. Artificial drainage was necessary as the first step in agricultural development. Because of the broad expanse of the level areas, outlets for drainage were lacking until ditches were constructed. Today large ditches cross the region in all directions, serving as outlets for extensive tiling systems, and making possible a very high type of agricultural development. Altho a very large part of the region has been adequately tiled, there are still numerous areas which will require additional artificial drainage before the most favorable conditions for crop production can be realized.

SOILS OF THE GLACIAL LAKE REGION OF NORTHWESTERN OHIO

A. Lacustrine Soils

The deposits laid down by the glacial lakes have weathered giving the lacustrine soils of the region. As is characteristic of such deposits, the soil-forming material shows a high degree of assortment. The well drained beach and other sandy deposits have weathered under conditions of good aeration producing light colored well drained soils. The poorly drained sandy and heavy deposits have existed under conditions favorable for the accumulation of considerable amounts of organic matter resulting in the development of dark colored soils. The absence of coarse material, such as pebbles or gravel, in the fine lacustrine deposits is notable.

Based on color and certain other differences in the soil profile, the soils have been grouped into a number of series.

Fox series, beach ridge phase.[1]—These soils are confined to the beach ridges of the region and have yellowish-brown to brown surface soils and brown to reddish-brown subsoils. At a depth varying from 18 to 40 inches the substratum consists of stratified sand and gravel containing a large percentage of limestone material.

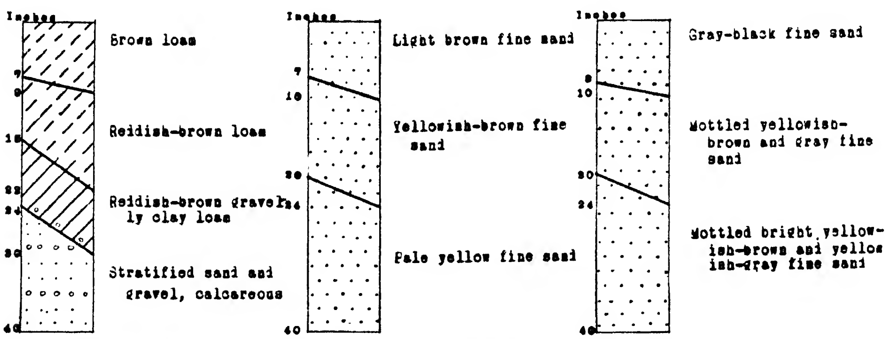
These soils occur on the long narrow ridges, which are the old beaches of the glacial lakes that once occupied the region, and were

[1]In older reports these soils were included in the Belmore series.

deposited by waves on the old lake shores. Because of the topographic position and gravelly nature of the subsoil, these soils are excellently drained. A considerable portion is utilized for fruit and vegetables. They are splendid soils for alfalfa. Fox loam, beach ridge phase, is an important type.

Plainfield series.—This series has light yellowish-brown to grayish-brown surface soils, yellow upper subsoils and pale yellow lower subsoils. The lower subsoil is invariably sandy to a considerable depth. In the lake-plain region of Ohio these soils have an undulating to gently rolling topography. In places, as a result of wind action, these soils occupy a dune-like surface. The drainage is good to excessive, there being a tendency toward droughtyness during dry seasons.

Plainfield fine sand[2] is the most important type. The most extensive area is in western Lucas County where a broad sandy belt is known locally as the "oak openings". This soil occurs in small areas in many parts of the lake-plain.



Fox loam, beach ridge phase   Plainfield fine sand   Newton fine sand

Lucas series.—The Lucas series includes soils with a grayish-brown surface soil and a yellowish-brown upper subsoil. Faint mottlings may occur in the subsurface which represents a gradation toward the Fulton soils. The lower subsoil is heavy in texture and usually calcareous below about 36 inches. Below 40 or 50 inches the laminated nature of the slack water deposit is still in evidence. The topography is gently rolling to sloping and the surface drainage good. The underdrainage is fair to good. Because of the heavy subsoils in certain members of the series, tiling may be desirable for underdrainage. Lucas silt loam and silty clay loam are important types.

[2]In former reports this soil was called Dunkirk fine sand.

Fulton series.—The surface soil is a brownish-gray to gray; this is underlain by a much heavier horizon which is mottled gray, yellowish-gray, and yellow. The lower subsoil below 36 to 40 inches, which is invariably heavy in texture, is a grayish-yellow calcareous clay, mottled with gray and yellowish-brown. Both soil and subsoil carry practically no pebbles such as are so characteristic of glacial soils. Calcareous and iron concretions in places occur in the lower subsoils. The stratified or laminated nature of the parent material is quite commonly in evidence below 3 or 4 feet.

The topography is level to very gently undulating and both the surface and internal drainage are poor. Fulton silt loam and silty clay loam are important types.

Wauseon series.—This series includes soils of a sandy nature which have a dark gray to grayish-black surface soil. The upper subsoil is mottled yellowish-brown and bluish-gray. The lower subsoil as well as the substratum is heavy, usually a calcareous clay loam or clay. In northwestern Ohio the sandy material is probably lacustrine overlying a heavy substratum which may be either heavy lacustrine deposits or glacial drift. The topography is level to gently undulating and the drainage poor. Wauseon fine sandy loam is the most important type.

Napanee clay   Brookston clay   Toledo silty clay

Newton series.—The surface soils of the Newton series are dark gray to very dark gray. The upper subsoil is mottled bluish-gray and yellowish-brown. Below 24 or 25 inches the subsoil is mottled yellow and yellowish-gray. The substratum consists of sand or sand and gravel. The topography is level to gently undulating and the natural drainage poor. Newton fine sand and fine sandy loam are important types.

Toledo series[3].—The Toledo series includes soils with a dark gray to gray-black surface soil. The surface horizon is commonly shallower and lighter in color in the heavy members of the series. The upper subsoil is bluish-gray streaked with yellow. With increased depth the yellow color becomes more prominent. There is usually no marked change in texture within the soil profile, altho the material shows stratification characteristic of fine lacustrine deposits. The absence of pebbles is notable. The topography is level and the natural drainage is poor.

Toledo silty clay, the most extensive type, occurs in a large uniform area extending from northern Sandusky into eastern Lucas County. This is one of the most extensive flat areas in the State. The soil is very fertile, but is rather difficult to handle because of its extremely heavy texture. Other types which are less extensive, but are excellent soils, are Toledo very fine sandy loam, silt loam, and clay loam.

Maumee series.—This series includes the gray-black to black soils. It is not uncommon for the virgin soil to show a few inches of muck at the surface. The subsoil is gray to bluish-gray streaked with yellow. Below 24 inches the yellow color usually predominates. The topography is level and the drainage very poor. Maumee fine sand and fine sandy loam are the important types.

Warners series.—The surface soil is dark gray to black. This is underlain by a light gray marl high in calcium carbonate, which varies in thickness from 6 to 30 inches. The substratum is usually a dull yellowish-brown highly calcareous clay. The topography is level to very gently undulating, and the drainage poor. Warners loam is the most important type.

B. Deep Glacial Soils[4]

Altho the glacial lake covered a large part of northwestern Ohio, within this region there are large areas in which there is little or no evidence of deposition of a lacustrine material, in fact glacial drift is exposed at the surface, and it is this material which has weathered to characteristic glacial limestone soils. Because of differences in topography and drainage, a diversity of soils has resulted. These have been classified in a number of series, including the Miami, Napanee, Brookston, and Clyde.

[3]In earlier reports these soils were included in the Newton series which is now limited to soils with a sandy and gravelly substratum.

[4]For a complete discussion of the Glacial-Limestone Soils of Ohio see the Bimonthly Bulletin, Vol. 11, No. 1, Jan.-Feb., 1926.

Miami series.—The Miami series includes brownish-gray soils with a pale yellowish-brown subsurface. The subsurface may be slightly mottled with yellowish-gray in the more level areas. The upper subsoil from 16 to 24 or 30 inches is a dull yellowish-brown streaked with rust brown iron stains, and is commonly much heavier than the layers above or below. This is underlain by a friable calcareous, clay loam to clay.

Miami soils exist in association with the Brookston soils, on the slightly higher lying areas where conditions have not been favorable for accumulation of much organic matter. Thruout the lake plain the characteristic light colored drift soil more commonly belongs to the Napanee series than to the Miami. The former series has characteristically a much heavier upper subsoil and hence poorer underdrainage than the Miami soils. These soils occupy undulating to gently rolling topography, have fair to good surface drainage, and fair underdrainage. In northwestern Ohio the most important types are Miami loam and clay loam, whereas farther south in the State the silt loam and silty clay loam are extensive.

Napanee series.—This series includes soils with a gray to brownish-gray surface soil, and mottled yellowish-brown and yellowish-gray upper subsoil. The upper subsoil is much heavier than the layers above and also becomes heavier with depth. The lower subsoil is a heavy calcareous clay. Within the lake-plain these soils occur on slightly elevated areas where there has been little or no deposition of lacustine material, the soil being derived from the weathering of glacial drift. The topography is undulating to gently rolling. The surface drainage is fair to poor, and the underdrainage very poor, owing to the heavy character of the subsoil. The most important types are the Napanee clay loam and clay.

Altho derived from calcareous glacial drift, the lime has been so thoroly leached from the surface soil that a very acid condition is quite characteristic.

Brookston series.—The surface soil of this series is a dark gray to gray-black. Thruout the lake-plain region the surface soil is characteristically shallow, averaging from 5 to 7 inches. The upper subsoil is a bluish-gray mottled with yellow and yellowish-brown. Below 18 to 24 inches the subsoil is mottled yellow and bluish-gray. Friable calcareous glacial till occurs below 36 to 40 inches. These soils are characterized by the presence of small pebbles and an occasional boulder within the soil, indicating the glacial origin. They occupy level areas and the natural drainage is very poor.

Brookston clay is the most extensive representative of this series within the lake-plain and is also the most extensive soil of the region. It occurs in large uniform areas and is one of the best agricultural soils of northwestern Ohio. It is especially well adapted for the growth of sugar beets. A heavy phase of this soil, which is spoken of locally as "Paulding clay", occurs in the western part of the region in Paulding and adjacent counties. It is much heavier and consequently more difficult to drain than the typical Brookston soil. The Paulding County Experiment Farm is located on this heavy phase.

Clyde series.—The Clyde soils are dark gray-black to a depth of 10 to 18 inches. The upper subsoil is bluish-gray streaked with yellow and the lower subsoil is mottled gray and yellowish-brown. The friable calcareous glacial till usually occurs at 36 to 40 inches. Clyde soils are darker than the Brookston and the organic layer is deeper.

These soils occupy low, level areas, and are naturally very poorly drained. Altho widely distributed over western Ohio, they are of rather limited extent within the lake-plain. Clyde silty clay loam and clay are important types.

C. Shallow Glacial Soils (over limestone)

In certain parts of the region the mantle of glacial material rests on limestone at a depth of 20 to 30 inches, giving soils which are quite distinct from the deep glacial soils. They are especially characterized by a heavy clay horizon just above the bed rock, which is probably in part residual from limestone. Three series have been recognized: the Milton, Randolph, and Millsdale. The total area is very limited.

Milton series.—The surface soils are brown to reddish-brown and the subsoil is reddish-brown sticky plastic clay. This rests on limestone at 20 to 36 inches. The topography is level to gently undulating, but the drainage is good. The soils, as a rule, are very fertile, and, being well supplied with lime, are excellent for alfalfa. Milton silt loam and stony loam are important types. These soils are very inextensive within the lake-plain.

Randolph series.—This series includes soils with gray to brownish-gray surface soils, and subsurface, mottled pale yellow and light gray. The upper subsoil is a dense yellowish-drab to dull brown clay loam to clay. Bed rock occurs at 20 to 36 inches. The topography is level to gently undulating, and the surface drainage is fair, but the underdrainage is rather poor.

Randolph stony loam and loam are the characteristic soils within the lake-plain. These soils occur on the crests and slopes of low rock ridges such as exist in western Sandusky and parts of Lucas County. In places the surface of the land is strewn with numerous glacial boulders as well as limestone slabs. Some areas are so stony as to be of practically no agricultural value. Because of the shallow depth to bed rock much of the type is difficult to tile drain.

Millsdale series.—The surface 7 to 9 inches is dark gray to gray-black, and the subsoil bluish-gray streaked with yellow. The proportion of yellow increases with depth. Limestone bed rock occurs at 30 to 36 inches. The topography is level and the natural drainage very poor.

Millsdale clay loam and stony clay loam are the important types within the lake-plain. These soils exists along the borders of the low limestone ridges intermediate in position between the Randolph and Brookston. Where the soils are not stony and can be tiled adequately they have about the same agricultural value as the Brookston soils.

D. Terrace Soils

These soils are characterized by layers of stratified sand and gravel in the lower subsoil. They are confined to terraces in the valleys of present or former streams, and are commonly spoken of as "second bottom" lands.

Fox series.—The surface soils are brown to reddish-brown and the subsoils reddish-brown. At 2 to 5 feet the substratum consists stratified sand and gravel containing a large percentage of limestone material. The topography is level and the drainage excellent.

The profile of the typical soil is similar to that of the beach ridge phase already described in the group of lacustrine soils. The chief differences are in topography and mode of origin. The typical soil has a level topography and is a stream terrace; the phase exists on low narrow ridges and is a lake beach deposit. Fox loam and silt loam are important types in this region.

E. Flood Plain Soils

These soils are first bottom lands and are subject to annual overflow. They are recent alluvial soils, deposited by the present streams as wash from the surrounding upland glacial and lacustrine soils derived largely from limestone material. Two series have been recognized: Genesee and Wabash.

Genesee series.—The Genesee soils are grayish-brown to dark brown to 12 or 18 inches, underlain by a slightly lighter subsoil which continues to 36 inches or more with little change. These soils show little tendency toward differentiation into definite layers or horizons, but they do show considerable variation in texture from place to place. The topography is level and the drainage fair to good. Altho a large proportion of these soils is well drained, some areas could be improved with tiling. All of these soils are subject to overflow. Because of the great variation in texture of the upland soils, this series includes soils ranging from Genesee fine sand to clay loam. A part of these soils is utilized for permanent pasture.

Wabash series.—The Wabash series includes soils with gray-black to black surface soils and mottled bluish-gray and yellowish-brown subsoils. The surface is flat and the natural drainage poor. The land is subject to annual overflow. With adequate drainage these make excellent corn soils. The undrained lands are chiefly of value for permanent pasture. As with the Genesee soils there is considerable range in texture in this region varying from Wabash fine sand to silty clay loam.

STORAGE OF POTATOES

WEEKLY PRESS BULLETIN

"Keep potatoes in the dark, reasonably dry, and above freezing temperature, whether they are to be sold soon after the harvest or stored for winter", is the advice of John Bushnell, potato specialist at the Ohio Agricultural Experiment Station.

Carelessness in exposing the crop to sunlight for several days results in a greening. This is accompanied by the development of a disagreeable and mildly poisonous solanin. To prevent this potatoes should be covered or moved to a dark storage as soon as possible after digging.

When this precaution to prevent greening is taken by moving the potatoes to storage or covering them with straw, the accumulation of moisture may seem serious, as potatoes normally give off moisture, or sweat, after digging. This sweating is usually more disagreeable than dangerous. If the tubers are sound and free from injuries when stored, the moisture rarely leads to rotting.

Removing the excess moisture by ventilation will prevent moisture stains and the crop will be more attractive when removed from storage.

Altho the temperature is not important in the fall, it becomes very important when the crop is held thru the winter. The temperature in storage should be between 36 and 40 degrees by the middle of December. If the temperature is above 40 degrees after the middle of December the potatoes will sprout and the shrinkage may be serious.

FARM MACHINERY COSTS IN OHIO

J. I. FALCONER

The sales price of farm machinery in Ohio over a period of years is given in the table below. It is interesting to note that the price of some of the machinery used on Ohio farms is now lower than the pre-war price, the index number of cost price at present varying from 216 for a double disk to 60 for a Ford truck. It is also interesting to note that the prices of the five gas-driven machines are all lower in price than pre-war. Excluding gas-driven machines, the weighted index number for the price of farm machinery was 148 in 1923; 178 in 1924; 168 in 1925; and 167 in 1926. Assuming, however, that 30 percent of the machinery cost on Ohio farms is for gas-driven machines, the index number for the total machinery cost was 125 in 1923; 146 in 1924; 138 in 1925; and 138 in 1926. It is estimated that machinery makes up about 10 percent of the total yearly expense on an Ohio farm.

TABLE 1.—FARM MACHINERY PRICES

Items	1914	1920	1922	1923	1924	1925	1926
Plow, 14 inch steel beam	$ 12.40	$ 22.40	$ 18.00	$ 18.00	$ 22.75	$ 20.50	$ 20.50
Plow, 14 inch sulky	34.00	67.25	56.75	52.00	71.50	67.50	67.50
Plow tractor, 3-bottom	93.50	178.25	142.50	108.50	124.25	124.25	125.30
Double disk, 4-horse	44.25	87.70	76.15	78.00	101.15	96.35	97.35
Corn planter	45.50	82.75	73.00	54.00	77.00	71.00	73.50
Grain drill	84.50	145.25	128.40	128.00	161.00	146.00	141.00
Mower	38.00	65.00	59.60	58.00	69.90	64.65	64.65
Rake, side delivery	49.50	80.25	73.25	74.00	96.00	92.00	91.00
Loader, hay	56.00	100.00	86.00	88.00	113.50	107.00	107.00
Binder	124.50	199.00	180.90	182.00	214.50	200.00	199.50
Manure spreader	100.00	168.00	148.00	130.00	160.00	142.50	142.50
Corn cultivator, single row	23.75	51.55	41.25	38.00	54.25	50.50	48.25
Gas engine, 2 horse power	52.50	61.75	56.50	54.00	58.60	51.00	51.00
Tractor, Fordson	....	850.00	395.00	430.00	495.00	495.00	485.00
Truck, Ford	....	600.00	430.00	370.00	365.00	365.00	365.00
Automobile, Ford	490.00	575.00	348.00	295.00	265.00	290.00	310.00
Truck, 1¾—ton	....	1,710.00	1,535.00	1,485.00	1,485.00	1,480.00	1,400.00

SUMMARY OF 4,666 FARM RECORDS IN OHIO FROM 1910-1925

J. I. FALCONER

Since 1910 the Department of Rural Economics has been making financial summaries of the year's business on various Ohio farms. Permanent records of all these summaries have not been preserved. However, 4,666 such summaries are now available. In some counties, such as Huron, Scioto, and Washington, records have been taken for several years on practically the same farms. In other counties records for only one year have been secured. The data given below show the principal sources of income as represented by cash sales from these farms; the main sources of income have been arranged in order of importance. The receipts are total cash receipts from sales. The expenses are cash farm expenses not including as an expense any interest on the investment. Labor income is figured by deducting the farm expenses and 5 percent interest on the investment from the farm receipts. In figuring the labor income an increase in the inventory of working capital is considered a receipt; a decrease in the inventory, an expense for the year. Labor income is not a measure of the farmer's wage nor of the amount of money which he will have available to spend. The figures should not be used to make a comparison of the profitableness of farming in different counties, since in some counties, such as Highland, all farms along the road were included; in others, such as Greene, for 1918 only the best farms were included. A comparison, however, of the labor income on a group of farms over a period of years will give a good indication of fluctuations in the profitableness of the farming business. It is interesting to note the relative increasing imporance of poultry as a source of income on those farms where records were secured over a period of years.

FARM BUSINESS SURVEYS

County	Principal sources of receipts in order of value	Year covered by surveys	Farms	Receipts per farm	Expenses per farm	Labor income
			No.	Dol.	Dol.	Dol.
Allen and Putnam	Hogs, cattle, wheat, oats, beets, corn	1918	40	6,692	3,887	2,182
	Hogs, wheat, cattle, corn, dairy, oats	1919	40	7,496	4,135	1,458
	Hogs, cattle, beets, wheat, corn, dairy	1920	52	5,464	3,140	−1,212
	Hogs, cattle, dairy, poultry, beets, hay	1921	36	3,739	2,489	−2,067
	Hogs, cattle, wheat, poultry, beets, dairy	1922	32	4,222	2,452	−153
Auglaize	Hogs, cattle, wheat, dairy, poultry	1910	120	1,914	944	340
	Dairy, hogs, poultry, wheat	1922	12	2,192	1,097	571
	Dairy, hogs, poultry, wheat	1923	14	2,570	1,273	640
	Hogs, dairy, poultry	1924	13	2,902	1,433	860
Belmont	Dairy, poultry, wheat, sheep	1921	13	3,255	2,045	448
Brown	Hogs, dairy, poultry, wheat	1923	18	2,019	936	595
Butler	Hogs, dairy, wheat, poultry, sheep	1923	21	3,425	1,719	819
	Hogs, dairy, poultry	1924	19	3,415	1,645	924
	Hogs, poultry, dairy, wheat	1925	13	3,750	1,501	1,850
Clermont	Hogs, dairy, wheat, poultry, sheep	1923	19	1,747	758	486
Clinton	Hogs, dairy, wheat, poultry	1923	14	2,940	1,207	1,144
Columbiana	Dairy, cattle, hay, hogs, work off farm, horses	1911	156	1,661	950	263
	Dairy, wheat, poultry, hogs	1917	61	2,868	939	1,359
Cuyahoga	Grapes, black raspberries, blackberries, strawberries	1917	36	1,379	943	17
	Grapes, black raspberries, blackberries, strawberries	1918	36	1,894	1,008	460
Franklin	Potatoes, tomatoes, onions, soybeans	1916	48	3,526	1,399	1,109
	Potatoes, tomatoes, onions, soybeans	1917	34	1,996	1,514	50
	Potatoes, tomatoes, soybeans, onions	1918	34	2,346	1,675	241
	Dairy, wheat, hogs, corn, cattle	1916	48	4,950	1,516	1,800
	Dairy, hogs, poultry, wheat, fruit	1923	9	2,735	1,263	705
	Dairy, hogs, poultry, wheat	1924	24	3,703	1,822	965
	Hogs, dairy, poultry, wheat	1925	32	4,201	1,756	1,812

FARM BUSINESS SURVEYS

County	Principal sources of receipts in order of value	Year covered by surveys	Farms	Receipts per farm	Expenses per farm	Labor income
			No.	*Dol.*	*Dol.*	*Dol.*
Geauga	Dairy, potatoes, cattle, poultry	1914	161	1,601	784	362
	Dairy, cattle, poultry, outside work, maple syrup	1915	115	1,728	913	309
	Dairy, cattle, poultry, wheat	1916	18	4,151	1,920	1,209
	Dairy, cattle, oats, poultry, potatoes	1917	12	3,615	1,908	1,084
	Dairy, cattle, poultry, wheat	1919	7	4,697	2,017	1,778
	Dairy, cattle, poultry, maple syrup, potato	1920	7	4,177	2,186	865
	Dairy, cattle, hay, maple syrup, poultry, potato	1921	9	3,348	2,458	—319
	Dairy, cattle, maple syrup, poultry	1922	12	4,179	2,336	643
Greene	Hogs, wheat, dairy, cattle	1918	73	7,087	2,414	3,176
	Hogs, cattle, wheat, corn, dairy, sheep	1920	16	5,549	4,425	—1,084
	Hogs, wheat, cattle, dairy, poultry, sheep	1921	18	3,251	2,147	—841
	Hogs, wheat, dairy, cattle, corn, sheep	1922	20	4,621	2,946	917
	Hogs, wheat, cattle, dairy, sheep, poultry	1923	20	4,255	3,116	—734
	Hogs, wheat, cattle, dairy, sheep, poultry	1924	17	5,743	3,071	908
Guernsey	Poultry, sheep, dairy, beef	1923	21	2,275	1,218	614
		1924	27	1,988	1,199	519
		1925	17	1,988	950	726
Henry	Corn, poultry, hogs, dairy	1921	28	2,766	1,814	102
	Corn, hogs, poultry, dairy, beets	1922	29	....	....	416
	Corn, poultry, dairy, beets	1923	24	3,518	1,402	970
	Poultry, hogs, corn, dairy, beets	1924	18	4,488	1,690	1,573
	Hogs, poultry, corn, wheat, dairy	1925	15	4,155	1,353	1,592
Highland	Hogs, wheat, cattle, poultry, dairy	1915	81	2,186	891	585
	Hogs, dairy, wheat, poultry	1923	15	2,307	1,124	489
Huron	Wheat, hogs, dairy, sheep, poultry	1917	58	4,018	663	2,422
	Wheat, hogs, dairy, sheep, poultry	1918	33	4,314	1,665	1,854
	Wheat, hogs, dairy, sheep, poultry	1919	28	4,729	1,687	2,227
	Wheat, dairy, hogs, sheep, poultry	1920	26	3,395	2,527	—125
	Wheat, dairy, hogs, sheep, poultry	1921	23	2,766	2,198	—288
	Dairy, wheat, hogs, sheep, poultry	1922	18	2,846	1,569	464
	Dairy, wheat, hogs, sheep, poultry	1923	19	3,436	2,019	567
	Dairy, sheep, wheat, hogs, poultry	1924	15	3,665	2,024	987
Lake	Dairy, fruit, truck, poultry	1916	89	2,501	1,229	679
Lorain	Dairy, wheat, fruit, truck, poultry	1917	62	4,436	1,564	2,031

FARM BUSINESS SURVEYS

County	Principal sources of receipts in order of value	Year covered by surveys	Farms	Receipts per farm	Expenses per farm	Labor income
			No.	*Dol.*	*Dol.*	*Dol.*
Medina	Dairy, cattle, wheat, hay, poultry, hogs	1920	17	6,205	3,908	37
	Dairy, cattle, wheat, hay, poultry, hogs	1921	16	4,360	3,043	—883
	Dairy, cattle, hay, poultry, wheat, hogs	1922	15	3,800	2,623	—202
	Dairy, cattle, poultry, hay, wheat, potato	1923	17	4,419	2,969	743
	Dairy, cattle, poultry, hay, wheat, hogs	1924	15	4,472	3,178	—549
Mercer	Hogs, poultry, dairy, wheat	1923	15	2,529	1,265	527
	Hogs, poultry, wheat, dairy	1925	11	2,607	1,237	512
	Hogs, poultry, dairy, wheat	1925	10	3,043	1,464	1,332
Miami	Tobacco, dairy, corn, hogs, wheat, poultry	1914	106	1,693	574	487
	Hogs, dairy, tobacco, wheat, cattle.	1915	89	1,704	569	493
Montgomery	Hogs, dairy, wheat, tobacco, cattle, poultry	1915	100	2,041	794	572
Morgan and Noble	Sheep, cattle, poultry, dairy	1922	51	1,735	738	401
Paulding	Sugar beets, corn, oats, wheat, hogs	1919	48	4,808	1,992	1,051
Portage	Dairy, cattle, hogs, wheat, poultry, potatoes	1914	67	1,158	531	209
	Dairy, wheat, potatoes, hogs	1915	54	1,401	632	351
Putnam	Hogs, dairy, beets, poultry, wheat	1925	20	3,566	1,478	911
Sandusky	Hogs, wheat, oats, dairy, corn, cattle	1915	84	2,255	715	667
Scioto	Dairy, wheat, hogs, truck, potatoes	1918	31	3,844	1,299	1,025
	Dairy, wheat, hogs, truck, potatoes	1919	38	3,250	1,327	1,397
	Dairy, wheat, hogs, truck, poultry	1920	40	2,572	1,685	254
	Dairy, hogs, wheat, truck, poultry	1921	33	2,257	1,919	—334
	Dairy, hogs, wheat, poultry, truck	1922	28	2,414	1,587	204
	Dairy, hogs, wheat, poultry, truck	1923	23	2,350	1,414	283
	Dairy, poultry, hogs, wheat	1924	12	2,995	1,525	635
Shelby	Hogs, dairy, wheat, poultry, beef	1919	11	4,634	1,829	1,606
	Hogs, dairy, wheat, poultry, oats	1920	11	4,139	2,110	830
	Hogs, dairy, wheat, poultry, beef	1921	11	2,867	523	—1,856
	Hogs, dairy, wheat, poultry, beef	1922	11	2,716	908	662
	Hogs, dairy, wheat, poultry, beef	1923	7	3,226	1,825	315
Stark	Dairy, wheat, hogs, truck	1916	69	2,055	851	472

FARM BUSINESS S :VEYS

County	Principal sources of receipts in order of value	Year covered by surveys	Farms	Receipts per farm	Expenses per farm	Labor income
			No.	*Dol.*	*Dol.*	*Dol.*
Summit	Dairy, wheat, potatoes, poultry, hogs	1917	60	2,503	844	1,081
Trumbull and Portage	Dairy, cattle, poultry, work off farm	1914	90	1,201	532	252
	Dairy, cattle, poultry, work off farm	1915	58	1,345	649	261
	Dairy, cattle, wheat, potatoes, hay, poultry	1918	40	4,837	2,671	1,315
	Dairy, cattle, wheat, potatoes, poultry, maple syrup	1919	40	5,536	3,355	1,173
	Dairy, cattle, wheat, potatoes, poultry, hay	1920	40	6,011	3,475	—105
	Dairy, cattle, potatoes, poultry, hay, wheat	1921	44	3,905	2,549	—727
	Dairy, cattle, poultry, potatoes, wheat, maple syrup	1922	36	4,315	2,693	131
Warren	Hogs, dairy, poultry, wheat	1923	17	3,120	1,362	1,048
Wayne	Dairy, poultry, wheat, hogs	1923	16	3,585	1,718	988
	Wheat, poultry, dairy, hogs	1924	13	3,483	1,767	1,394
Washington and Barlow	Cattle, poultry, sheep, dairy, wheat, apples	1914	75	1,109	469	313
Marietta and Lowell	Tomatoes, cabbage	1920	90	3,804	1,536	1,611
	Tomatoes, cabbage	1921	79	2,503	1,693	128
	Tomatoes, cabbage	1922	79	2,186	1,496	11
	Tomatoes, cabbage	1923	70	3,231	1,581	987
	Tomatoes, cabbage	1924	72	3,437	1,723	1,106
Palmer	Sheep, poultry, cattle, hay, wheat, apples	1912	47	801	396	109
	Cattle, poultry, sheep, hogs, hay, work off farm	1913	34	779	386	87
	Cattle, poultry, hogs, sheep, dairy, wheat	1914	52	812	377	147
	Cattle, poultry, sheep, hogs, wheat, dairy	1915	57	806	396	128
	Cattle, poultry, hogs, sheep, dairy, wheat	1916	55	1,026	413	313
	Cattle, sheep, poultry, hogs, dairy, wheat	1917	25	1,571	547	666
	Cattle, poultry, sheep, hogs, dairy, work off farm	1918	47	1,431	772	250
	Cattle, poultry, wheat, sheep, hogs	1919	51	2,046	870	784
	Poultry, cattle, hogs, dairy, work off farm, wheat	1920	59	1,275	911	—30
	Poultry, cattle, work off farm, dairy, sheep, hogs	1921	60	1,006	841	—187
	Poultry, cattle, work off farm, sheep, dairy, hogs	1922	64	1,324	832	135

FEED PRICES

J. I. FALCONER

Feed purchased makes up about 15 percent of the total farm expenses in Ohio for the year. While the relatively low prices for farm crops prevailing during the past few years have kept low the farm income, the farmer as a feed buyer has also reaped some little benefit. Especially has this been true in the deficit feed-producing areas in the eastern half of the State where feed purchased makes up a higher percentages of the total farm expense.

In Tables 1 and 2 six representative feeds, which make up the bulk of feeds purchased, are used to construct an index of prices. It is believed that these are fairly representative. As a whole the weighted index of these feeds in July was 130; this compared with an index of 161 for all farm expenses. Of the various major items of expense on the farm for the past five years, feed has probably been the lowest. Of the feeds, bran, oats, and cottonseed meal have ranked relatively low in price, while tankage has been and is high.

TABLE 1.—FEED PRICES

	1910—14 Average	1923 March	1924 March	1925 March	1926 March	1926 September
Corn	$ 0.60	$ 0.83	$ 0.82	$ 1.24	$ 0.77	$ 0.90
Oats	0.40	0.50	0.52	0.55	0.46	0.46
Bran	27.00	35.00	30.00	33.00	30.00	28.00
Tankage	40.00	75.00	60.00	55.00	69.00	75.00
Oilmeal	37.00	54.00	44.00	47.00	52.00	51.00
Cottonseed meal	33.00	48.00	42.00	42.00	37.00	39.50

TABLE 2.—INDEX OF FEED PRICES
AVERAGE 1910-1914=100

	1923 March	1924 March	1925 March	1926 March	1926 July
Corn	138	137	206	130	140
Oats	125	130	137	115	115
Bran	130	111	122	111	104
Tankage	187	156	137	172	188
Oilmeal	148	119	127	140	138
Cotton seed	145	127	127	111	117
Weighted index	140	127	153	127	130

FREIGHT RATES ON OHIO BUTTER, CHEESE, AND CONDENSED MILK

C. G. McBRIDE

Ohio butter, cheese, and condensed milk move to market in large quantities by freight. Milk and cream move almost exclusively as express in refrigerated cars or as baggage on passenger trains. This study deals with the rates on butter, cheese, and condensed milk moving by freight from certain points in Ohio to consuming centers mainly on the eastern seaboard.

The present freight rates from a group of representative points in Ohio to eastern markets are as follows:

TABLE 1.—Present Freight Rates on Butter and Cheese In Cents Per 100 Pounds

Shipping point	Destination						
	Columbus	Cincinnati	Pittsburgh	Baltimore	New York	Philadelphia	Boston
Car lots							
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
Toledo	40	49	52	70.5	73.5	71.5	78.5
Lima	35.5	41	53	72 5	75.5	73.5	80.5
Springfield	29	34	51	74.5	77.5	75.5	77.5
Cincinnati	39	....	56	79	82	80	87
Columbus	....	39	48.5	70	73	71	78
Cleveland	41	52	41	64	67	65	72
Less than car lots							
Toledo	51	62	66	90	97	95	103
Lima	45	52.5	67	96.5	99.5	97.5	105.5
Springfield	37	43	64.5	99	102	100	102
Cincinnati	49.5	....	71	105.5	108.5	106.5	114.5
Columbus	....	49.5	61.5	93	96	94	102
Cleveland	52.5	66	52.5	85.5	88.5	86.5	94.5

The rates given in Table 1 for butter and cheese are class rates—car lots fall into Class 3; less than car lots, into Class 2. Condensed milk is placed in Class 3 on less than car lots and in Class 4 on car lots. In freight classification, Class 1 has the highest rate.

The freight rates, in cents per hundred pounds, for a typical group of markets are given in Table 2. Comparing present rates with those in effect previous to 1915, we find an index number of 190 for freight rates. The Ohio index number for prices paid to farmers for butter in 1925 was 170. This 20-point disadvantage of the butter producer, expressed in percentage of value of the product, does not, however, show up as unfavorably as would be the case

in commodities of great bulk and lower value per pound. It means that in the pre-war period the average freight charges to the markets listed were 25.6 cents in car lots and 46.2 cents in less than car lots on a hundred pounds of butter worth $25. This was 1.4 and 1.8 percent of the farm value of the butter. In 1925 the charges were 68 and 89.25 cents for hauling a hundred pounds now worth on the average $42, or in percentages, 1.6 and 2.1 percent.

A similar compilation on grain and hay would show very much higher percentages.

TABLE 2.—Freight Rates on Butter and Cheese for Various Periods, From 1915 to 1926, in Cents per Hundred Pounds

Shipping point and market	Jan., 1922 to present date	Aug., 1920 to Jan., 1922	June, 1918 to Aug., 1920	June, 1917 to June, 1918	Jan., 1915 to June, 1917	Base rate before 1915
		On car lots				
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
Toledo to New York......	73.5	81.5	58	46.5	40.6	38.50
Toledo to Columbus........	40	44.5	31.5	25	21.9	20.75
Lima to Boston...........	80.5	89.5	64	51	44.4	42.25
Lima to Baltimore........	72.5	80.5	57.5	46	39.9	38.00
Springfield to Pittsburgh.	51	56.5	40.5	32.5	28.1	26 75
Springfield to Philadelphia	75.5	84	60	48	41.6	39.50
Cleveland to New York...	67	74.5	53	42.5	37.1	35.25
Cleveland to Boston.......	72	80	57	45.5	39.4	37.50
Cincinnati to Baltimore...	79	87.5	62.5	50	43.6	41.50
Cincinnati to Pittsburgh..	56	62	44	35	30.6	29.00
Columbus to Philadelphia	71	79	56.5	45	39.1	37.25
Columbus to Boston........	78	86.5	61.5	49	42.8	40.75
		On less than car lots				
Toledo to New York..........	97	108	77	61.5	53.3	50.75
Toledo to Columbus...........	51	56.5	40.5	32.5	28.1	26.75
Lima to Boston................	105.5	117	83.5	66.5	58	52.25
Lima to Baltimore............	96.5	107	76.5	61	53	50.50
Springfield to Pittsburgh.....	64.5	71.5	50.5	40.5	34.5	33.75
Springfield to Philadelphia...	100	111	79	63	54.9	52.25
Cleveland to New York.......	88.5	98.5	70.5	56.5	49	46.75
Cleveland to Boston..........	94.5	105	75	60	52	49.50
Cincinnati to Baltimore......	105.5	117	83.5	66.5	58	52.25
Cincinnati to Pittsburgh....	71	79	56.5	45	39.1	37.25
Columbus to Philadelphia	94	104.5	74.5	59.5	51.7	49.25
Columbus to Boston...........	102	113.5	81	64.5	56.3	53 50

INDEX NUMBER OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

For about a year now there has been a gradual decline in the wholesale price level. In spite of this, however, employment is reported as general, wages high, and a continuation of the high consuming power.

Farm prices in Ohio fell from 161 in June to 158 in July and then dropped to 149 in August. The August and September price level was twelve points below that of May and June. Wheat, potatoes, and apples showed the most marked decrease in price level, while hogs and chickens showed smaller declines. As a result the purchasing power of a unit of Ohio farm products fell from 104 in June to 99 in August and September.

TREND OF PRICES AND WAGES
1910-1924=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Ohio farm wages	Non-agricultural products	Farm prices U. S.	Farm prices Ohio	Purchasing power of Ohio farm products
1913	102	....	104	105	100	104	102
1914	100	100	102	97	102	105	105
1915	103	101	103	101	100	106	103
1916	130	114	113	138	117	121	93
1917	181	129	140	182	176	182	100
1918	198	160	175	188	200	203	103
1919	210	185	204	199	209	218	104
1920	230	222	237	241	205	212	92
1921	150	203	164	167	116	132	88
1922	152	197	145	168	124	127	84
1923	156	214	166	171	135	134	86
1924	152	218	165	162	134	133	87
1925	161	223	165	165	146	159	99
1925							
January	163	223	156	165	146	155	95
February	164	220	....	177	146	155	95
March	164	224	....	165	151	159	97
April	159	218	163	162	147	158	99
May	158	221	....	161	146	162	104
June	160	220	....	163	148	165	105
July	163	220	168	164	149	166	102
August	163	222	....	164	152	163	99
September	163	223	....	163	144	157	96
October	160	225	173	164	143	151	94
November	160	226	....	166	144	157	98
December	159	229	....	165	143	158	99
1926							
January	159	229	160	165	143	156	98
February	158	225	....	164	143	156	99
March	154	229	....	162	140	155	101
April	154	227	167	160	140	157	101
May	154	226	....	160	139	161	104
June	155	228	....	160	139	161	104
July	153	227	176	159	135	158	103
August	151	228	....	159	132	149	99
September	151	....	....	....	....	149	99

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Ohio Agricultural Experiment Station

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OHIO AGRICULTURAL EXPERIMENT STATION
Wooster, Ohio, U. S. A.

Fig. 1.—Actual distribution of the European corn borer in Ohio. Note the areas of heaviest infestation

BIMONTHLY BULLETIN

OF THE

Ohio Agricultural Experiment Station

VOL. XII, No. 1 JANUARY-FEBRUARY, 1927 WHOLE No. 124

THE EUROPEAN CORN BORER IN OHIO

L. L. HUBER AND C. R. NEISWANDER

Many questions have been asked us (within the last year or two) relative to the European corn borer. It is very encouraging indeed, to note that a large percentage of the questions are from school boys and girls; however, farmers, bankers, business men, and teachers are all well represented. For the benefit of our readers we are here repeating some of these questions and our answers to them. It is believed that a careful study of these questions and answers will result in a better understanding of the corn borer problem.

Because the corn borer is recognized as a very serious pest a great deal has been said and written about it. Unfortunately, some of that which has been said and written has led to confusion. Due to the recent introduction of the pest and our limited knowledge of its habits, perhaps this was inevitable. As we learn more about the behavior of the borer this confusion will be eliminated. In the pages that follow the questions and answers, we have attempted to summarize the problem as we now understand it.

QUESTIONS AND ANSWERS

1. *What is the European corn borer?* We generally think of this insect as a grayish larva, or caterpillar, a little more than one inch long when mature, which feeds on every part of the corn plant except the roots. It is as a larva that the insect tunnels up and down the stalk or into the ear, thus causing the damage. However the corn borer is not the only insect which injures corn in this way. The common stalk borer and the smartweed borer are additional examples.

Like many other insects the corn borer passes thru four distinct stages—namely, the egg, the larva, the pupa, and the adult stages. Adults, or moths, fly and deposit eggs during the latter part of June and thruout July. The eggs hatch in four to six days and the young larvae, which at first feed upon the leaves, soon enter the stalks where they remain for the next ten or eleven months. The following June these full grown larvae, which have passed the winter in the stalks, transform into small, brown, shuttle-shaped objects known as the pupae. After spending about two weeks in the pupal stage, adult moths emerge ready to deposit their eggs on the new crop of corn. See Figures 2, 3, and 4.

Fig. 2.—European corn borer moth—twice natural size

2. *Where did the European corn borer come from?* It originally came from Europe.

3. *When did the corn borer come to North America?* It is thought that it came to Canada as early as 1910. It was first discovered in the United States in 1916.

4. *How did it get into North America?* It came to us in shipments of broom corn.

Fig. 3.—European corn borer larva greatly enlarged

5. *Is the corn borer a serious pest in Europe?* This insect often causes serious losses in Europe, especially in Italy, Hungary, and Russia. Losses of 25 percent of the corn crop are frequently reported and in some years the losses go as high as 75 to 100 percent in certain areas.

6. *How does the corn crop of Europe compare in size with that of the United States?* Hungary, Roumania, and Italy are the main corn producing countries of Europe. Statistics for the five-year period, 1911 to 1915, show that for every 13 bushels of corn produced in these three countries the United States produced 100 bushels. The

difference in production, of course, would not be so great as indicated if the entire corn production of Europe were included.

7. *Has the European corn borer stopped the production of corn in Europe?* The corn borer has not stopped the production of corn in Europe.

8. *What did the corn borer feed upon before corn was introduced into Europe?* Corn has been grown in Europe about 400 years and the corn borer has been in Europe a great deal longer; hence its original food was not corn. It is probable that the original food plant was the wild hop.

9. *When was the corn borer first discovered in Ohio?* It was first found in 1921 in practically all of the townships along Lake Erie.

10. *How did this insect get into Ohio?* Undoubtedly the corn borer moths, favored by winds, flew across Lake Erie from Canada.

11. *How does the corn borer spread?* The usual means of dispersion is by flight of the moths. However larvae may be transported by automobiles or commercial carriers, hence the necessity of quarantine measures.

12. *How rapidly has the insect spread in Ohio?* In 1921 the corn borer was found in 21 townships; 52 in 1922; 96 in 1923; 253 in 1924; 307 in 1925; and 525 in 1926. See map page 2.

Fig. 4—The small white blotches on the corn leaves indicate the first evidence of corn borer injury. The newly hatched larvae feed upon the leaves first

13. *Is the infestation in Ohio increasing?* Yes. In 1921 only a few borers were found in the infested area. The same area showed a maximum infestation of 1 percent in 1922; 17 percent in 1923; 40 percent in 1924; about 60 percent in 1925; and 100 percent in 1926. There was a 500 percent increase in numbers of borers this past season in certain areas.

14. *Where are the areas of heaviest infestation in Canada?* The areas of heaviest infestation in Canada are in the province of Ontario directly north of Ohio.

15. *Has the European corn borer caused commercial loss in Canada?* It has caused heavy losses three times during the last few years, and has caused some loss each year since 1920. Damage in Ontario has been so great that the corn acreage has been reduced about 90 percent since 1920. See Figure 6, upper part.

Fig. 5.—A badly damaged hill of corn. Note the broken stalks

16. *Where are the areas of heaviest infestation in Ohio?* The areas of heaviest infestation in Ohio are in Lucas and Ottawa Counties in northwestern Ohio and Lake County in northeastern Ohio. See map.

17. *Will the corn borer prove equally serious over all parts of Ohio?* There is some evidence that it will not prove equally serious in all parts of the State. It will cause the most trouble in northwestern Ohio.

18. *Has the insect occasioned commercial loss in Ohio?* No appreciable commercial loss was suffered in Ohio up to 1926. This year, however, appreciable commercial losses have been noted over limited areas in Lucas, Ottawa, and Lake Counties. See Figure 6.

19. *Is there any reason to believe that the corn borer will become as serious in Ohio as in Canada?* There are several reasons to believe that this insect will cause as much damage in parts of Ohio as it has caused in Canada. There are no reasons to believe the contrary.

20. *Will the European corn borer stop the growing of corn in Ohio?* We do not expect that this insect will stop the growing of corn either in Ohio or the corn belt states.

21. *Will the corn borer cause a decrease in land values in Ohio?* We do not know. There may be a temporary decrease but as the

insect becomes prevalent over the entire corn belt there probably will be a tendency for land values to return to normal.

22. *Does the corn borer show a preference for sweet corn over field corn?* We have little or no evidence of such preference, but the damage is greater to sweet corn than to field corn.

23. *If this pest does not prefer sweet corn, why is sweet corn damaged more than field corn?* The cause of the greater damage to sweet corn may be ascribed to the fact that, on the average, the

Fig. 6.—Corn infested with European corn borer

Above, a heavily infested field in Canada. This field had an average of more than 30 borers per stalk. The crop was an entire loss.

Below, a heavily infested field in Lucas County, Ohio. This field had 100 percent stalk infestation and an average of 10 borers per stalk.

stalks of field corn are about twice as tall and twice the diameter of sweet corn and contain eight times as much volume as sweet corn. It follows then, all other factors being equal, that it would require eight times as many borers to produce injury in field corn equivalent to the injury in sweet corn. Furthermore, a few borers in an ear of sweet corn make the ear unsalable (if the prospective buyer sees them) while the same number of borers in an ear of field corn might be of negligible consequence.

24. *What shall we do with our sweet corn after the ears are harvested?* Feed, burn, or plow under completely sweet corn stalks before June 1 of the following year. If you cut it, cut as low as possible. Handle sweet corn stalks in the same manner as field corn.

25. *Are all varieties of corn attacked?* There is no known variety that is free from corn borer attack.

26. *Does the European corn borer live in plants other than corn?* This insect can live in many plants, altho in Ohio and Canada it prefers corn almost exclusively. After the larvae are fully or partly grown they sometimes migrate to weeds and grasses in the corn field or other adjoining fields.

27. *What aid may we expect from native enemies?* Native insect parasites and predators are not expected to help us very much. Birds are likely to prove of but little consequence.

28. *Of what value are imported parasites?* The introduction of imported parasites in Ohio is an experiment, hence we can only consider them as a possible control. We do not know how much good they may finally do.

29. *Are weather and climate important factors in the life of the corn borer?* Without doubt weather and climate are extremely important factors influencing the behavior of the corn borer.

30. *Will crop rotation aid in control?* Crop rotation can be of only indirect assistance in that it will promote and encourage better care of the corn crop and more thoro disposal of crop refuse.

31. *Can we use insecticides?* The behavior of the insect is such that spraying and dusting offer but little encouragement.

32. *Is late planted corn damaged less than early planted corn?* Yes. The later corn is planted the less it may be damaged.

33. *Will late planting be recommended as an additional control measure?* If we can discover a variety, type, or strain that will produce a satisfactory yield when planted late enough to escape corn borer damage, late planting will be recommended. Experiments along this line are now in progress. See Figure 7.

34. *What is the possibility of finding a resistant variety?* The possibility of finding a variety that is immune seems to be rather remote but we cannot say that such a variety will never be found or developed. However the discovery of a variety, type, or strain that is less attractive to the adults and more resistant to larval attack is within the realm of probability.

35. *What will the corn shredder and the ensilage cutter do tc corn borer larvae?* All borers that enter a silo are either dead when they go into it or die soon afterward. Likewise most of the borers that pass thru a shredder are killed or die within a short time.

36. *What should be done with stubble?* We recommend that when corn is cut that it be cut extremely low. If it is to be plowed under low cutting is unnecessary.

37. *What is meant by low stubble?* By the use of low cutting corn binders it is possible to cut corn so that the stubble will be three inches long. Such stubble is considered low. Stubble that measure twelve inches or more is considered high.

38. *Why should corn be cut low?* When the stubble is 2 inches high it contains about 5 percent of the total number of borers in the entire crop; when the stubble is 12 inches high about 15 percent of the borers remain; when the stubble is 2 feet high it contains about 30 percent of the total number of borers. Corn should be cut low if it is not planned to plow under the stubble.

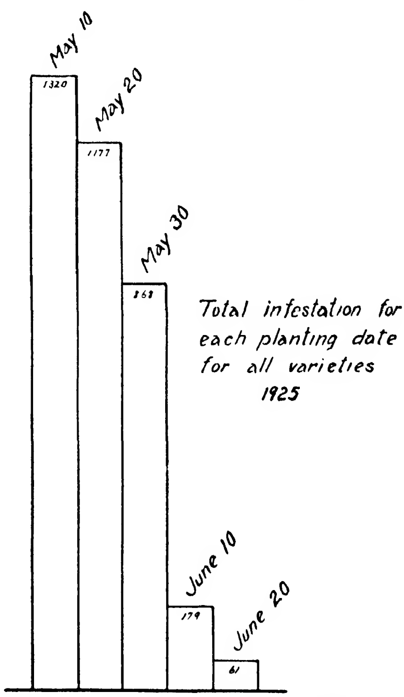

Fig. 7.—Showing the difference in infestation of corn planted on five different dates. Late corn is infested least

39. *How can corn be cut so that extremely short stubble remains?* When corn is cut with a binder the remaining stubble is generally shorter than when cut by hand.

40. *What should be done with standing stalks?* Standing stalks should be plowed under or burned, not later than June 1. If impossible to plow them under they should be broken off, raked two ways and burned.

41. *Why should stalks and high stubble be plowed under or burned before June 1?* About the middle of June the moths begin to emerge. Stalks and high stubble must be destroyed before the moths emerge, otherwise it will do no good to plow under or burn.

42. *Should barnyards be cleaned up?* Ordinarily barnyards or barnlots will need little or no attention. In exceptional cases, however, some attention may be advisable. When the stalks are trampled well into the manure by livestock practically all borers are destroyed.

43. *Should open feed lots be cleaned up?* All corn stalks should be destroyed.

44. *How deep should plowing be done?* Plow just as deep as was your custom before the borer came.

45. *What happens to the borers when the stalks are plowed under?* When infested stalks are plowed under the borers always come to the surface. If the plowing is done in the winter the borers will remain underground all winter but will come up in the spring. If the plowing is done in the early fall or the spring the borers will come to the surface at once. The borers can travel only when the weather is warm.

46. *What happens to the borers when they come to the surface?* When the buried larvae come to the surface they begin a search for shelter. If the plowing was inefficient the borers will crawl into stalks that remain on the surface; but if the plowing was done thoroly the borers will be unable to find new shelter. If no shelter can be found the borers die.

47. *Should plowing be done in the spring or in the fall?* Plow at any time; the time of year is not important.

48. *What constitutes clean or thoro plowing?* Corn leaves, corn stalks, and weeds can seldom be found on the surface of the ground when the plowing has been thoro.

49. *Should "hogging" corn be discontinued?* If the uneaten part of the crop can be thoroly plowed under, hogging may be continued as usual. However, it is difficult to completely plow under the tangled crop remnant.

50. *Can the corn borer be eradicated?* No.

51. *Can the corn borer be stopped?* No.

52. *Can the corn borer be retarded?* It has undoubtedly been retarded but to what extent we shall never know.

53. *What do we mean by control?* By control we mean that we shall so adjust our farming practices that we can still produce corn profitably. Eventual control will undoubtedly depend largely

not only on the efficiency of whatever methods we adopt but also on the cooperative efforts of the farmers. Control does not necessarily mean that we must attempt to eradicate or stop the borer. By the time all control measures are in operation the corn borer will probably be established over the major part of the corn belt.

THE CORN BORER CONTROL PROGRAM

The experimental work may be conveniently discussed under three headings—namely, (1) parasite introduction, (2) agronomical investigations, and (3) mechanical measures. Entomologists believe that the ultimate solution of the corn borer problem will require the employment of measures included in all these three phases of attack.

Relative to the possibilities of control by parasites it should be remembered that there are few reasons to feel either particularly optimistic or particularly pessimistic. On the one hand, it must be kept in mind that parasites do not control the corn borer in Europe; yet, on the other hand, there are those who believe that these same parasites brought here may become very valuable indeed. The introduction of parasites is an experiment; hence sure and immediate results cannot be guaranteed.

What are the possibilities of agronomic research and agricultural practices? It has been established that corn planted late is damaged less by the borer than corn planted early. Furthermore, it has been demonstrated that some varieties are more resistant to borer attack than others. For example, strong, sturdy, vigorous stalks withstand borer attack better than weak and slender stalks. But under conditions of heavy infestation even the most sturdy stalks suffer severe damage. Due to the facts that no known variety will withstand severe borer attack and that early planted corn is more severely damaged than corn planted late it would seem that we may be compelled in the future to plant corn at a much later date than is now considered normal. It is common knowledge, however, that late planted corn does not yield as well as corn planted at the normal planting date and in addition the late corn is likely to be damaged by frost. In order to be prepared for what now seems to be an eventuality of the near future, corn-breeding experts are making special efforts to develop new varieties which can be planted not only late enough to escape severe corn borer damage but also which will produce a profitable yield. Associated with this major effort many other agronomic phases of the problem are being investigated.

The only methods of control for which the farmers themselves are responsible at present are those involving ordinary farm practices. For lack of a better term, such practices are generally known as mechanical measures of control. But mechanical measures are also in the experimental stage. They include all methods by which corn borer larvae can be destroyed or their numbers reduced. The equipment used includes farm machinery such as corn binders, ensilage cutters, shredders, plows, and rakes. In addition to machinery we must include not only livestock, which eat or trample the borers, but also burning. All of these methods aim to destroy the larvae that are within the stalks or stubble. Corn stalks that pass thru an ensilage cutter or a shredder, for example, will have few live borers in the finished product. When stalks are raked and burned the borers are likewise destroyed. When infested stalks and stubble are plowed under the borers come to the surface but, if the plowing was done in a thoro manner, practically all of the borers will perish from lack of shelter. Plowing under stalks does not in itself kill the borers but the borers die when they can find no refuse stalks and leaves on the surface of the plowed ground. By the use of the new and specially designed 16-inch bottom plows that are now on the market it is possible to do a satisfactory job of clean plowing. Agricultural engineers are of the opinion that a 12-inch plow is entirely inadequate to plow under standing stalks and at the same time leave no debris on the surface. A 14-inch bottom plow may be of service if the corn is not too large and if the plow be provided with accessory attachments to aid in coverage. Engineers further state that a skillful operator may do a better job ot plowing with a mediocre plow than an unskilled operator with a good plow. Disking stalks or high stubble has no standing whatever in a good corn borer control program. Disking stalks is practically equivalent to doing nothing, hence such a practice should be promptly discontinued.

From these statements it readily can be understood that from the standpoint of controlling the borer some farm practices are better than others. We strongly recommend not only the continued employment of the desirable farm practices but the elimination of the undesirable practices, such as disking standing stalks and high stubble. In making this suggestion we realize, of course, that elimination of undesirable practices may cause a temporary disarrangement of farm procedure. However, it is to be kept in mind that should the corn borer get beyond control, farm procedure may be disarranged to an infinitely greater degree. We have here what appears to be a choice between two evils—namely, growing

corn with additional cost, which the public eventually will pay, or perhaps growing no corn at all.

That there may be no delusion, perhaps it is well to explain at this time what we consider to be the status of mechanical control measures. The most casual reader understands that the entire mechanical control program is based upon the fact that the more borers killed by plowing, burning, shredding, ensiling, etc., the fewer moths the following year. If we have fewer moths there will be fewer eggs deposited on the new crop and consequently fewer borers. And a reduced number of borers will mean less damage. Therefore everything the corn grower can do in addition to what he was accustomed to do when no borers were present, can be considered as a good and worthy practice. However, there is a limit to what can be done by voluntary and practical farm operations. In other words, there will always be a certain number of borers which we shall not be able to destroy. The question then is, will these borers that remain be sufficiently numerous that their progeny will cause damage in spite of the clean farming practices? Unfortunately we are compelled to state that indications at present are that in some cases and in some parts of the State the employment of clean farming practices or practical mechanical measures alone may not avert serious damage. In such areas mechanical measures will be of tremendous value but in themselves may not be sufficient to prevent losses.

We make these statements now because there has been a great deal of publicity concerning the possibility of eradicating, stopping, or retarding the borer. It must be understood that the best cleanup is likely to fall short when it attempts the impossible. Cleanups are not meant to eradicate or stop the borer; they are meant as aids in keeping the number of the borers reduced to a minimum. To claim eradication by mechanical efforts is to speak without regard to the biology of the insect. To claim that anything we can do will stop the borer is to acknowledge ignorance of its habits and behavior. And to entertain hope of retarding it to an appreciably greater degree than it has been retarded in the past by voluntary efforts is to be extremely optimistic. While we advise and recommend the use of all practical and sane mechanical methods, still we are not unmindful of the fact that mechanical measures have their limitations. The fact that we recognize the limitations, however, should not in the least deter or prevent us from carrying out a mechanical control program that is practical and sensible. Recognition of these limitations should only serve to prevent us from trying to accomplish what is obviously impossible.

SOIL POTASSIUM

J. W. AMES

Chemical analyses of a wide range of soils show that the total amount of potassium, except in peat and muck, is largely in excess of the nitrogen and phosphorus. Because of its abundance in most soils, potassium is generally regarded as the least frequently deficient of the three plant-food elements considered of importance from the standpoint of additions in fertilizers.

Availability, as applied to plant nutrients of the soil, is a relative term. Since the particular requirement of a crop and its ability to obtain nutrients from the soil determine, in a measure, the availability of any element necessary for good crop production, the available supply of an element in a given soil may be sufficient over a longer period for some crops than for others.

TABLE 1.—Potato Yields, Averages For Two 15-year Periods

Plot	Fertilizer added in each rotation of 3 years, pounds per acre	15-year average 1894—1909		15-year average 1909—1923	
		Yield	Increase	Yield	Increase
		Bu.	*Bu.*	*Bu.*	*Bu.*
2	Acid phosphate, 320	182.62	14.96	87.59	−2.08
3	Muriate potash, 200	178.79	9.52	111.51	23.10
6	Acid phos., 320; nitrate soda, 200; dried blood, 50	182.74	20.79	99.24	12.13
8	Acid phosphate, 320; muriate potash, 200	189.09	30.66	124.21	38.75
9	Mur. potash, 200; nitrate soda, 200; dried blood, 50	171.52	12.16	118.26	34.44
	Average unfertilized yield	154.02	....	86.70	....

Indications from crop yields.—Yields of potatoes and corn from certain fertility plots on Wooster silt loam soil that contains 30,000 pounds of total potassium per acre to the depth of 6⅔ inches show the effect of the gradual depletion of available potassium.

Potatoes, wheat, and clover have been grown in a 3-year rotation at Wooster for 30 years. Thruout this period phosphorus has been more effective than potassium for wheat and clover. The same was true for potatoes for several years after the experiment was started. There has been, however, a marked contrast in the relative effects of potassium and phosphorus during the latter half of the period thru which this experiment has been continued. The yields of potatoes for several plots, as given in Table 1, show that phosphorus was more important than potassium during the first

TABLE 2.—Corn Yields; Unlimed and Limed Soil, Section C

Plot	Fertilizer applied in 5-year period, pounds per acre		Yield and increase in bushels per acre							
			1908		1913		1918		1923	
			Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase
2	Acid phosphate, 320	Unlimed	31.00	11.93	24.00	12.81	18.93	7.12	13.79	6.98
		Limed	36.79	8.25	28.71	13.35	16.29	—.19	22.21	4.00
3	Muriate potash, 260	Unlimed	20.00	.36	8.29	—1.37	10.43	—1.33	6.57	.10
		Limed	33.36	4.48	17.64	2.21	32.36	16.48	37.86	19.15
6	Acid phosphate, 320; nitrate soda, 480	Unlimed	38.93	14.19	22.29	10.58	24.50	11.36	22.93	15.55
		Limed	47.79	17.48	31.29	14.50	26.71	5.19	19.43	—2.26
8	Acid phosphate, 320; muriate potash, 260	Unlimed	39.43	13.36	27.93	15.81	23.36	9.98	17.00	9.83
		Limed	46.29	15.29	38.29	19.57	37.86	14.96	40.86	18.41
9	Muriate potash, 260; nitrate soda, 480	Unlimed	28.57	3.43	14.21	3.47	18.07	5.16	12.07	5.74
		Limed	41.57	10.42	26.93	6.93	38.50	17.33	39.21	17.23
11	Acid phosphate, 320; muriate potash, 260; nitrate soda, 480	Unlimed	40.00	17.12	32.93	23.50	20.57	8.85	34.00	28.05
		Limed	49.29	18.60	42.29	21.48	45.50	24.59	50.29	26.62

15-year period, while the opposite has been true during the last 15-year period. This was due to the heavy drain upon the soil's supply of potassium by the potato crops.

The corn crop requires an abundance of available potassium. Corn has been grown for 32 years at Wooster in a 5-year rotation of corn, oats, wheat, clover, and timothy. Various fertilizer treatments have been made and all plots have been limed on one-half and left unlimed on the other half. During the later years of this experiment the corn crop on the limed soil has given marked evidence of a depletion of the available potassium supply. The crops of the rotation were larger on the limed land and removed more potassium from it than the smaller crops removed from the unlimed soil. Corn yields for several plots of the section from which soil samples were taken for chemical study are given in Table 2. It will be observed that during the earlier years of the experiment, the potassium supply appeared to be more nearly adequate for corn than in later years, when there has been marked response to additions of potassium on the limed land.

Indications from soil analyses.—Soils from fertility experiment plots were analyzed to ascertain whether there was a correlation between the more active potassium, soluble in dilute acid, and the soil treatment and crop yields. Results for several of the plots of the 5-year rotation fertility experiment are shown in Table 3. The greater removal of potassium by increased crop yields on limed as compared with unlimed soil is indicated by the the smaller amounts of dilute acid-soluble potassium found in soil from the limed portion of all plots regardless of fertilizer additions. Approximately the same amount was dissolved from limed soil fertilized with muriate of potash, as from unfertilized and unlimed soil. The lowest amount of acid-soluble potassium was found in the limed ends of plots 2 and 6 receiving, respectively, acid phosphate and a combination of acid phosphate and nitrate of soda. On these plots no potash was supplied in the fertilizer, but the crop yields have been increased by the phosphorus and nitrogen supplied, resulting in a heavier drain upon the supply of native potash in the soil.

One-half of each of the fertility plots on the clay loam soil of the Northeastern Test Farm at Strongsville is cross dressed with floats, and the other half with lime. Larger crop yields have been produced on the soil which receives phosphorus, especially where potash also has been applied. The acid-soluble potassium content of uncultivated Strongsville soil is 100 pounds per acre as compared

with 88 pounds for the limed soil, and 72 pounds for the phosphated soil. The soluble potassium in limed soil from the plot fertilized with muriate of potash is 156 pounds and in the phosphated soil from this plot 94 pounds.

TABLE 3.—Soluble Potassium. 5-year Rotation Fertility Plots

Plot	Fertilizer treatment, 5-year period, pounds per acre	Potassium pounds per acre	
		Limed	Unlimed
1	None	46	68
2	Acid phosphate, 320	34	74
3	Muriate potash, 260	72	154
4	None	46	74
5	Nitrate soda, 480	46	62
6	Acid phosphate, 320; nitrate soda, 480	34	64
7	None	56	72
8	Acid phosphate, 320; muriate potash, 260	60	120
9	Muriate potash, 260; nitrate soda, 480	64	152
10	None	46	68
11	Acid phosphate, 320; muriate potash, 260; nitrate soda, 480	62	122
18	Manure, 18 tons	68	104
19	None	54	62
24	Acid phosphate, 480; muriate potash, 260· ammonium sulphate, 165	68	102
25	None	52	74

Liberation of potassium.—Various agencies operate to release potassium from soil-forming minerals, but the amount at the disposal of a crop during its growth is a comparatively small proportion of the total reserve supply. It is estimated from the average composition of the crops grown in the 5-year rotation at Wooster that 160 pounds of potassium is removed in 5 years from the unlimed soil and 200 pounds from the limed soil on Plot 11, which receives acid phosphate, muriate of potash, and nitrate of soda in the fertilizer treatment. This amount exceeds by 70 pounds the amount of potassium supplied by the muriate of potash added during the same period.

TABLE 1.—Effect of Salts on Solubility of Potassium—
Water Soluble Potassium in Pounds per Acre

	Calcium sulphate	Sodium nitrate	Ammonium sulphate	Water only
Silt loam, no treatment	18	30	26	14
Silt loam, limed	12	16	14	10
Silt loam, acid phosphate	12	14	14	10
Silt loam, acid phosphate, lime	12	14	10	8
Silt loam, muriate of potash	34	40	44	28
Silt loam, muriate of potash, lime	14	16	14	14
Paulding clay, uncultivated	30	26	30	24
Paulding clay, unfertilized	24	22	30	20
Trumbull clay loam, uncultivated	30	34	42	16
Trumbull clay loam, unfertilized	18	30	34	16

It has been asserted that the application of certain materials including gypsum and nitrate of soda may cause the liberation of potassium from the more insoluble forms in the soil. Tests of several soils treated with calcium sulfate, ammonium sulfate, and sodium nitrate and allowed to stand for some time previous to extracting with water, furnished the results in Table 4. The materials were mixed with the soil at the following rates: ammonium sulfate, 200; sodium nitrate, 400; and calcium sulfate, 800 pounds per acre. These additions all appear to have slightly increased the solubility of potassium in most of the soils treated.

MIXED VS. PURE FOREST PLANTATIONS

R. R. PATON

The forest plantings that are now being made in the State are largely of the pure, rather than the mixed type. Plantations of a single species are somewhat simpler to set out than those of mixed species. However, a mixed plantation, when proper species are combined, has certain advantages which outweigh this slight advantage of simplicity in planting a pure stand.

When two species of trees which are suitable for combining in a plantation are planted together, the likelihood of securing a successful stand is increased. Any disease or insect outbreak which might threaten a certain species in a region would remove only a portion of a mixed plantation instead of threatening the entire stand, as would be the case if it were composed of only the one species. In addition to this, some insect enemies have less effect on a susceptible species if it is found mixed with other trees. For example, the white pine weevil causes less damage to white pines if they are mixed with red pines than if they are planted pure. Another instance of this is the comparative immunity of black locusts to the locust borer when they are planted in a hardwood stand, whereas they are often completely ruined when planted pure in an adjacent field.

Tulip poplar appears to do best at the outset when planted in a thin shade, and the best matured timber trees usually are in mixture with other species. Black walnut and some of the other native trees are found at their best in mixed stands.

Mixed stands, more nearly than pure stands, approach the natural type of woods. Rarely are the native woods found in this region composed of but a single species; they consist rather of a mixture of several species.

Trees do better in mixture because the different species make different demands upon the soil for food, because they have different light requirements, and because there is often more beneficial competition for crown space.

The first of these factors tends to bring about closer utilization of the plant foods available on the site. The roots of the different species often penetrate to different depths and in that way make use of the soil to better advantage, one species occupying the upper layers and the alternating species occupying the lower layers. This enables each tree to obtain more food and increased growth is the result.

The slightly different growth rates of two species such as red and white pine stimulate growth in these trees more than would be the case if only one species were present and the growth rate about the same for all trees. Crown competition tends to produce taller, straighter trees, and also improves the amount of natural pruning which takes place on the lower parts of the bole more than would be the case among trees which offer little competition to each other.

Looking further into the future certain other advantages of a mixed stand appear. Market conditions, which change from year to year, will be more easily met with a stand composed of more than one species than by a stand which contains only one type. A market at a certain period may be dull for pine, for instance, but spruce may find a ready sale. If the stand is composed of pine alone, this market condition would compel the owner either to hold the timber for a favorable market or to sell at a low price. On the other hand, with a mixed stand of spruce and pine the owner could sell the spruce at the desired time, thus obtaining a revenue from it which would enable him to hold the pine for a better market.

When a mixed planting is to be made it is essential that species which are adapted to the same conditions be associated. Generally speaking, hardwoods will not make the best growth on soil which produces the best conifers, and vice versa. Neither can all hardwoods be grown on the same site with equal success.

Evergreen species can be grown successfully on light, well-drained, or sterile soils, while hardwoods prefer the richer soils. This, when taken together with the fact that as a rule the conifers

grow more rapidly than many of the hardwoods, makes it impractical in many cases to combine hardwoods and conifers on the same site. However, some combinations, such as white pine and sugar maple in the northern portion of the State, or tulip poplar and pine in the southern portion, will prove satisfactory.

The conifers lend themselves readily to many different combinations, and success is fairly certain with all the mixtures. Red and white pines make a successful combination. Red pine and Norway or white spruce do well together in Ohio on fairly light soils.

The hardwoods offer more difficult problems and some combinations would be of little value. The oaks mix well with each other or with the maples. Ash, maple, and walnut do well together on rich bottom lands. Black locust can be successfully grown when planted in a native stand of hardwoods if the original stand is not too dense. Tulip poplar also does well if planted in an open stand of native hardwoods.

There are several different methods of mixing species in a plantation. Alternating the species checker-board fashion is always a good combination, tho alternating them by rows is almost as good and somewhat simpler. Planting the species in double alternate rows has been done with reasonable success, but this method has few advantages over the single alternate rows.

SOME FACTORS IN GREENHOUSE SOIL STERILIZATION

A. G. NEWHALL

Soil sterilization is recognized as necessary for the control of certain diseases in the culture of vegetables under glass. In order to sterilize most effectively, due consideration must be given certain limiting factors. This is true whether the buried pipes, inverted pan, harrow, or buried tile method be employed.

In the fall of 1926 an attempt was made to find out how far down in the soil growers were getting killing temperatures with these methods. Killing temperature is arbitrarily designated here as 150° F., altho it is known that different microorganisms have different thermal death points which range between 135° and 155°. Unless soil is heated to at least 150°, therefore, good sterilization can not be expected. The importance of a killing temperature at considerable depth is apparent since nematodes in sandy soils at summer temperatures are known to become abundant at the remarkable depth of two or three feet.

Over three hundred temperature readings were accordingly taken in several commercial vegetable greenhouses near Cleveland while soil sterilization was in progress. A milk pasteurizing thermometer was employed on account of its sturdy construction and great sensitivity. The accompanying tables show the temperatures actually obtained under commercial conditions.

Variations in temperature.—After steaming with the harrow, readings made 6 inches apart but at the same depth, differed by as much as 100 degrees (Table 3). Under the pan method variations of 50 degrees were not uncommon. With the buried-tile method, in which the steam is commonly left on for several hours, there was much less variation. The regions which failed to become heated to killing temperatures were usually those under the old paths between the tomato or cucumber rows. This failure to obtain a killing temperature thruout the soil explains in part the quick return of nematodes and other parasitic organisms in spots in greenhouses after sterilization.

Compactness of soil.—Since steam follows the path of least resistance, the texture or porosity of the soil is of great importance. Great variations in compactness and moisture content of the soil are common in greenhouses. The effect of thoroly loosening the soil by careful forking and of breaking the clods is shown in Table 1.

TABLE 1.—Effect on Steam Penetration of Thoroly Loosening Soil. Pan Treatment 1½ Hours, Fahrenheit Temperature Readings Covering 45 sq. ft.

Depth	Worked up with fork	Not worked
Soil A. Heavy, wet clay loam, under pan 1½ hours		
Inches	*Degrees*	*Degrees*
3	....	170, 145, 180 140, 145, 155
6	200, 200, 219 205, 210, 205 190, 190, 190	90, 70, 100 80, 90, 85
7	195, 195, 180 170, 170, 170	....
8	145, 150, 175 130, 130, 130	....
Soil B. Clay loam, under pan 1 hour		
6	170, 160, 150	130, 120, 110

Moisture content of soil.—Water beyond a certain amount clogs up the pores of the soil and hinders quick steam penetration. Furthermore, the addition of water to a soil requires more heat to raise the soil temperature. Water requires nearly four times as many thermal units as sand or clay to raise the temperature a degree. A soil containing 60 percent moisture requires about twice as much heat to raise the temperature to a given point as it does when the moisture content is only 20 percent. That this has a bearing on the practical steaming of greenhouse soils is borne out by the following data:

TABLE 2.—Effect of Soil Moisture on Steam Penetration, Pan Method 1 Hour

Soil type	Depth	Moisture (dry weight)	Temperature (average of several readings)
	Inches	*Percent*	*Degrees*
A 1 Sandy loam	8	26.0	200
2 Sandy loam	8	29.5	190
3 Sandy loam	8	33.0	160
B 1 Sandy loam	6	27.8	180
2 Soggy clay loam*	6	41.0	125

*Spot 5 feet from B 1 and under the same pan.

In one house where the soil was a heavy clay and had been soaked a few days before the steaming was begun, poor results were obtained after steaming for one hour by the pan method. In many places at a depth of 6 inches the temperature was found to range between 100° and 150° F. However, in one part of the house

where the overhead irrigation line was out of order and the soil under it had not received much water, the temperatures 6 inches below the surface ranged between 160° and 195° F.

In the six greenhouses where temperature records were obtained, the deepest penetration was in the soils that had not been watered for several weeks. The poorest results from steaming were obtained in the two houses where the soil had been watered only a few days before sterilization. The difference in efficiency could not be attributed to boiler pressure, length of time of treatment, or method of preparing the soil. It seems evident, then, that in a heavy clay soil where there is relatively less space between the particles for passage of steam, it is important that the water content should not be too high.

There was some evidence that good penetration (10 inches) can be obtained in very hard soil, if it be dry enough (a sandy loam with 26 percent moisture). There was also evidence indicating that killing temperatures can be obtained at considerable depth (9 inches) even in a very moist (50 percent) clay soil provided it is loose enough.

Pan versus harrow method.—A comparison of the pan and harrow methods was made in one greenhouse. The soil was a very heavy clay and was quite wet, carrying over 60 percent of moisture (dry weight basis). The pan and harrow were placed side by side on parallel lines of steam pipe. The steam pressure was maintained near 75 pounds. The following temperatures were recorded at the end of $1\frac{1}{4}$ and $2\frac{1}{2}$ hours:

TABLE 3.—Soil Temperatures Under the Pan and Harrow Methods on a Heavy, Wet Clay Soil

Depth	At end of 1¼ hours		At end of 2½ hours	
	Pan	Harrow	Pan	Harrow
Inches	*Degrees*	*Degrees*	*Degrees*	*Degrees*
6	205, 205, 190	140, 120, 150	205, 205, 200	130, 125, 135
	195, 172, 180	185, 160, 145	200, 195, 207	140, 160, 180
	185, 182, 190	110, 115, 160	205, 200, 205	210, 205, 200
		140, 200, 135		140, 160, 185
		130, 110, 90		115, 110, 180
7	150, 170, 152			
	140, 150, 110			
	110, 120, 140			
8	110, 100, 150		200, 195, 185	140 (soft spot)
			200, 190, 198	
9			170, 185, 160	
10			140, 145, 140	
14			160 (soft spot)	

It is evident that under the conditions of this test the harrow can not be trusted to give killing temperatures even at a depth of six inches. Tho a heavy canvas was spread over the harrow and weighted down, the steam failed to penetrate the soil in all directions from the points of the teeth. There was much variation in the temperatures attained at 6-inch depths under the harrow. Even when the steam was left on for 2½ hours, double the usual period, good killing temperatures were not obtained 6 inches below the surface.

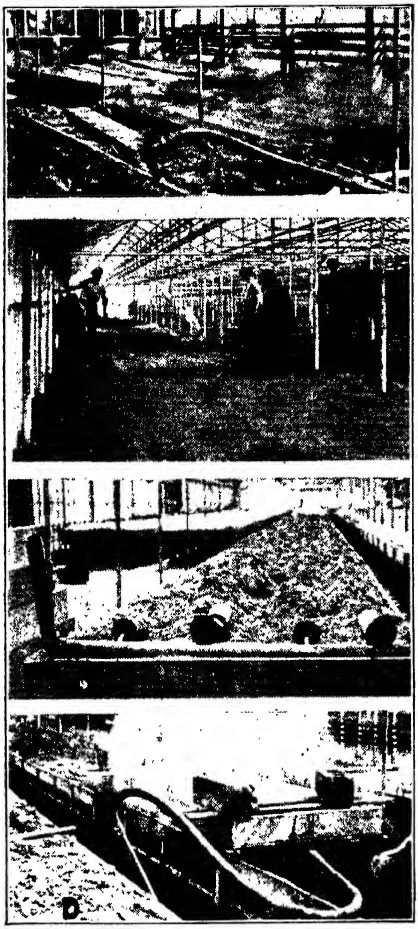

Fig. 8.—Sterilizing Plant Beds

A. The inverted pan and harrow sterilizers in operation.
B. Laying canvas over soil in buried tile method.
C. Temporary buried tile method.
D. Inverted pan method.

The buried tile method.—No direct comparison was made between this and other methods under strictly comparable conditions. Where the lines of tile are placed at a depth of 12 inches in a heavy clay soil it requires between 2 and 3 hours for the steam to come to the surface of the soil. At this time it is customary to lift the canvas and fork up any areas that seem to be obstructing the escape of the steam. The canvas is then lowered and the steam left on for several hours more. In one such area of 20 square feet the temperature was found to be 70° F. at 2 inches below the surface. At 6 inches it was 110°, at 7 inches 130°, and at 8 inches 162°, and becoming still higher on approaching the hot tile. Where the steam had penetrated to the surface the temperature was found to be well above 160° thruout the first 2 inches. Below this it reached 210°. At the center of hard lumps or wherever it was difficult to insert the thermometer, the tempera-

ture was 20 to 50 degrees lower. In several trials made after the steam had been turned into the tile for 5 to 10 hours the temperature was above 200° F. In one such test after eight hours of steaming the temperature was found to be 160° at a depth of 22 inches. This was below and between the lines of tile.

In conclusion, the evidence does not indicate that high steam pressures (100 pounds) are very much more effective than low pressures (30 to 40 pounds). The deepest penetration with the pan method, observed, was under a boiler pressure of 50 pounds. Killing temperatures were recorded frequently at 9- and 10-inch depths. The soil, however, was a sandy loam and had not been watered for more than 6 weeks. It contained only 26 percent moisture and was so porous that little seemed to be gained by loosening with a fork before steaming.

SUMMARY

1. Variations of 40° F. or more were often found between points 6 inches apart but at the same depth, in greenhouse soils after steaming for 1 to 3 hours.

2. The highest soil temperatures at the lowest depths were attained in the driest (26 percent) sandy soils. Conversely, the poorest steam penetration was in the wettest clay soils (60 percent moisture).

3. The importance of thoroly loosening the soil and of breaking up all the lumps before sterilizing is emphasized by the data reported.

4. Under strictly comparable conditions side by side in a heavy clay soil the harrow method proved much less effective than the pan.

5. In one trial on a heavy, wet clay, doubling the time of application of the pan, from $1\frac{1}{4}$ to $2\frac{1}{2}$ hours, increased the depth of steam penetration nearly 50 percent.

WARM WATER FOR WINTER LAYERS

D. C. KENNARD

It is essential that warm water be provided the layers during cold weather for best winter egg production. Poultry keepers accomplish this object in different ways. Heating the water in the drinking receptacle by means of electricity is convenient but electricity may not be available or economical. The use of coal oil lamps or heaters involves considerable fire hazard and is inconvenient. Consequently many poultry keepers heat the water in a feed cooker, kettle, or wash boiler and use pails for drinking receptacles. The objection to this method is that the water soon becomes cold and freezes. However, this difficulty can be largely overcome by insulating the water pail so as to conserve the heat. In other words the principle of the fireless cooker is used to keep the water warm.

HOW TO INSULATE THE WATER PAIL

The size of the pail will depend upon the size of the flock. A 12- or 14-quart pail for each 50 layers is about right. A pail with a considerably larger top than bottom is preferable since more of the water is within easy access of the birds. The pails of heavy galvanized iron with lugs for bail securely attached are best.

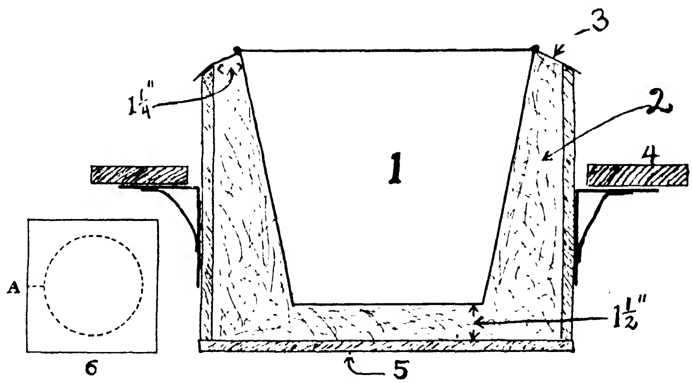

Fig. 9.—Insulated water pail and container

1. 12 or 14 quart galvanized water pail.
2. Straw or excelsior for insulation.
3. Galvanized sheet iron top to keep insulation dry.
4. 1 by 4 inch runing board.
5. Removable bottom.
6. Sheet iron top marked for cutting.

To insulate the water pail a square or round container somewhat larger than the pail is required (Fig. 9). The bottom of the container is attached with small nails so it can be removed easily when new packing is needed. Dry goods boxes may be used for making the containers. A piece of galvanized sheet iron of proper size is marked as in Figure 9, "A", and cut along the dotted line so as to fit snugly just under the rim of the pail and extend three-fourths inch beyond the sides of the container. It is made to slope one-half inch downward to the top edge of the container. This keeps the insulation material dry, which is very important.

To pack the container, first put 1½ inches of straw or excelsior in the bottom, then place the pail in the proper position and pack the straw or other insulating material firmly around it to the top. Then place the sheet iron covering around the pail and fit snugly by lapping the open edges and nail so as to insure ample slope away from the pail. The pail can easily be removed for rinsing or cleaning. One packing should last for a winter season. To repack turn upside down and pack from bottom rather than remove the top.

The running board is supported by shelf brackets 5 inches below the top of the pail and ½ inch from the container so as to avoid collecting dirt or catching drip water.

When the pail is properly insulated it is surprising how much longer the warm water retains its heat. During moderately cold weather a pail of hot water placed in the insulated container in the morning will serve the whole day. When it is very cold more hot water should be added at noon. By hot water is meant water in which the finger can be held for 5 or 10 seconds, or at a temperature of about 130° F. Care should be taken never to have the water hot enough to scald the chicken's tongue. Boiling water should never be used except for melting ice or mixing with cold water.

A winter feeding problem is to induce the layers to drink sufficient water for maintenance of health and egg production. The best solution is to keep warm water available during the entire day.

LESS LAND AREA REQUIRED TO FEED OHIO HORSES

J. I. FALCONER

One of the notable changes in Ohio farming since about 1910 has been the adoption of automobile and tractor power. This has led to a decrease of over 250,000 in the number of horses on Ohio farms, or nearly one horse per farm. While the substitution of mechanical power for horse power on the farm has greatly increased the productivity of farm labor it is also true that it has decreased the demand for farm products. For, while the horse is a farm-raised product, the tractor is a city-made product and runs on gasoline rather than grain and hay. Since, as it appears, horses formerly consumed approximately 25 percent of the feed consumed by livestock on Ohio farms, the horse provided a market of considerable importance for our farm products. Their decreasing number may, in no small part, be responsible for the prevailing low prices for oats and hay. To what extent has this substitution released land formerly needed to raise and feed our horses?

Horses on Ohio farms		
	1910	888,027
	1920	810,692
	1925	634,980
Decrease 1910-1925		253,047

The census shows a decrease of 253,047 in number of horses on Ohio farms from 1910 to 1925. Cost account data collected by the Department of Rural Economics show that, on the average, a farm horse will consume 24 bushels of corn, 27 bushels of oats, and 3850 pounds of hay per year. With our average crop yields, to grow these crops would take 0.6 acre of corn, 0.8 acre of oats, and 1.35 acres of hay. A total of 2.75 acres of crop land per horse. This acreage multiplied by 253,047, the decrease in number of farm horses, would give 695,880 acres as the land required to feed these horses.

The percentage decrease in number of horses in the cities, however, has been even greater than on the farms of the State.

Number Horses in Ohio cities		
	1910	188,041
	1920	83,179
	1926	58,000
Decrease 1910-1926		130,041

Since the horse in the city has no pasture and is fed more grain, it may be assumed that the acreage of crop land required would be one-fourth greater than that for the farm horse. This would make 3.45 acres per horse, or a total of 448,641 acres.

Furthermore cost studies have shown that on 3 farms having tractors the horses are fed some 15 percent less than those on farms having no tractor. There are about 30,000 Ohio farms having tractors. Assuming that these farms have an average of four horses it would normally require 11 acres of crop land to feed them. Allowing for the 15 percent reduction would reduce this by 1.65 acres per farm or a total of 49,500 acres.

Total Crop Acres Released

By decrease in farm horses	695,880
By decrease in city horses	448,641
By less feed on tractor farms	49,500
Total	1,194,021

The change in Ohio has thus far meant a loss in the market for 1,194,021 acres of farm products. This is approximately 10 percent of our total crop acreage. It would be sufficient acreage to feed 400,000 people.

OHIO FARM AND CITY VALUATIONS AS SHOWN BY INDEX NUMBERS 1915 to 1925

J. I. FALCONER

That Ohio cities have been prospering since the close of the war, especially since 1922, is readily seen by a comparison of property values by years since 1915 in three of the largest cities of the State—namely, Cleveland, Cincinnati, and Columbus. That agriculture has not fared so well is also readily seen by a comparison of farm land values for the same years.

Probably the best available and comparable figures on city real estate values are those arrived at by the tax assessor's office. It is these figures which have been used for the city valuation in the table below. Column 1 gives the index of values of all real property in the State in cities and incorporated villages. Columns 2, 3, and 4, respectively, give the valuation of all real property in cities and

incorporated villages in the counties in which Cleveland, Columbus, and Cincinnati are included. These three, it is true, include the value of real estate in the incorporated villages of the counties, but since the percentage of total values in the incorporated villages is relatively small in these counties, the figures for the counties as a whole will give a good indication of the movement of values in these three cities. Column 5 gives the tax valuation of all real property in the State outside cities and villages. Column 5 is based upon the value of farm land in Ohio as reported annually by the Crop Reporting service. It may be true that a small part of this increased value as reported may be due to appraising property nearer its full value in the last few years; but this has been as true of farm property as of city property, and the comparison of the relative change in value should still be valid.

City and Farm Values in Ohio 1913-1925
1915 Valuation=100

Year	As Appraised for Taxation					Crop reporters figures
	Entire State In cities and incorporated villages No. 1	Cuyahoga County Cleveland city and incorporated villages No. 2	Franklin County Columbus and incorporated villages No. 3	Hamilton County Cincinnati and incorporated villages No. 4	Entire State Outside of cities and incorporated villages No. 5	Farm land values
1911	86.14	....	....	....	97.61	....
1912	87.94	....	....	....	98.17	....
1913	90.40	85.06	97.28	96.93	98.71	....
1914	95.04	92.58	97.41	98.16	99.56	....
1915	100	100	100	100	100	100
1916	103.91	105.67	101.85	103.23	100.52	105.63
1917	116.69	124.56	107.69	124.76	103.31	112.67
1918	119.51	130.48	106.72	118.35	106.93	121.13
1919	126.69	136.53	122.42	119.05	108.74	128.17
1920	147.46	187.23	126.67	120.59	112.58	147.89
1921	148.41	172.79	130.36	122.92	113.34	123.94
1922	151.13	178.75	134.24	125.22	114.12	109.86
1923	162.02	209.75	140.30	129.46	114.72	109.86
1924	199.96	276.96	227.02	154.39	121.68	105.63
1925	214.91	287.66	225.12	190.13	122.67	98.59
1926	....	....	....	....	....	97.18

Letting the value of 1915 in each case equal 100, the table shows that since 1915 the value of real estate in Cleveland has increased 187 percent, in Columbus 125 percent, and in Cincinnati 90 percent, that in the State outside of cities and villages which would include the farm lands 23 percent, while the value of farm property as reported by the Crop Reporters has decreased 3 percent. It would, therefore, appears that if property values are an indication of prosperity for the past few years, the farm has not fared as well as the city.

LABOR REQUIREMENTS FOR CORN PRODUCTION IN 1907-1912 VS. 1920-1924

J. I. FALCONER

To all acquainted with Ohio agriculture it is evident that changing methods and practices have been leading to a considerable reduction in the labor required to perform the various farm operations. Specific data, however, which will measure these changes are not plentiful. The Station now has comparable data showing the average labor requirement for producing an acre of corn in southwestern Ohio in the period 1907-1912 and also in 1920-1924.

The records show that in 1907-1912, 36 hours of man labor and 48 hours of horse labor were used to produce an acre of corn; in 1920-1924, 25 hours of man labor and 38 hours of horse labor, a reduction of 30 percent in man labor and 20 percent in horse labor. Part of this saving in labor came thru the adoption of more efficient methods of performing certain operations such as the use of the tractor by some in plowing, the double disc in discing, or the two-row cultivator in cultivating. Other saving has come about thru the more general use of the corn binder and the shredder and in some sections thru husking a larger percentage of the corn from the stalk. The hours of man labor required per acre to perform certain operations in corn production then and now on the farms studied are as follows:

	1907-1912	1920-1927
Seed bed preparation	6.97 Hr.	5.15 Hr.
Planting	1.21 Hr.	1.08 Hr.
Cultivation	7.00 Hr.	4.22 Hr.
Other man labor	20.82 Hr.	14.55 Hr.
Total	36.00 Hr.	25.00 Hr.

Similar economies have been made in the labor requirements for producing other crops. At the same time the yield has been increased. It is this which has enabled Ohio to increase her agricultural output in the face of a decrease in farm population. It may even be said that it is this situation which has in no small part caused the decrease in farm population.

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

Since June last there has been a decline of twelve points in the index of prices for Ohio farm products. During the same period the all commodity index has decreased but two points. In price relationship, therefore, agriculture has moved to an unfavorable level. Lower prices for wheat, sheep, and hogs have helped to bring this about. On the favorable side it is estimated that the crop yields of the State are some eleven points above last year. An increase in the wages of farm labor is also apparent.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Ohio farm wages	Non-agricultural products	Farm prices U. S.	Farm prices Ohio	Purchasing power of Ohio farm products
1913	102	....	104	105	100	104	102
1914	100	100	102	97	102	105	105
1915	103	101	103	101	100	106	103
1916	130	114	113	138	117	121	93
1917	181	129	140	182	176	182	100
1918	198	160	175	188	200	203	103
1919	210	185	204	199	209	218	104
1920	230	222	237	241	205	212	92
1921	150	203	164	167	116	132	88
1922	152	197	145	168	124	127	84
1923	156	214	166	171	135	134	86
1924	152	218	165	162	134	133	87
1925	161	223	165	165	146	159	99
1925							
January	163	223	156	165	146	155	95
February	164	220	....	177	146	155	95
March	164	224	....	165	151	159	97
April	159	218	163	162	147	158	99
May	158	221	....	161	146	162	104
June	160	220	....	163	148	165	105
July	163	220	168	164	149	166	102
August	163	222	....	164	152	163	99
September	163	223	....	163	144	157	96
October	160	225	173	164	143	151	94
November	160	226	....	166	144	157	98
December	159	229	....	165	143	158	99
1926							
January	159	229	160	165	143	156	98
February	158	225	....	164	143	156	99
May	154	226	....	160	139	161	105
June	155	228	....	160	139	161	105
July	153	227	182	159	136	158	104
August	152	227	....	160	133	151	99
September	153	231	....	161	134	149	97
October	153	....	177	....	130	149	97

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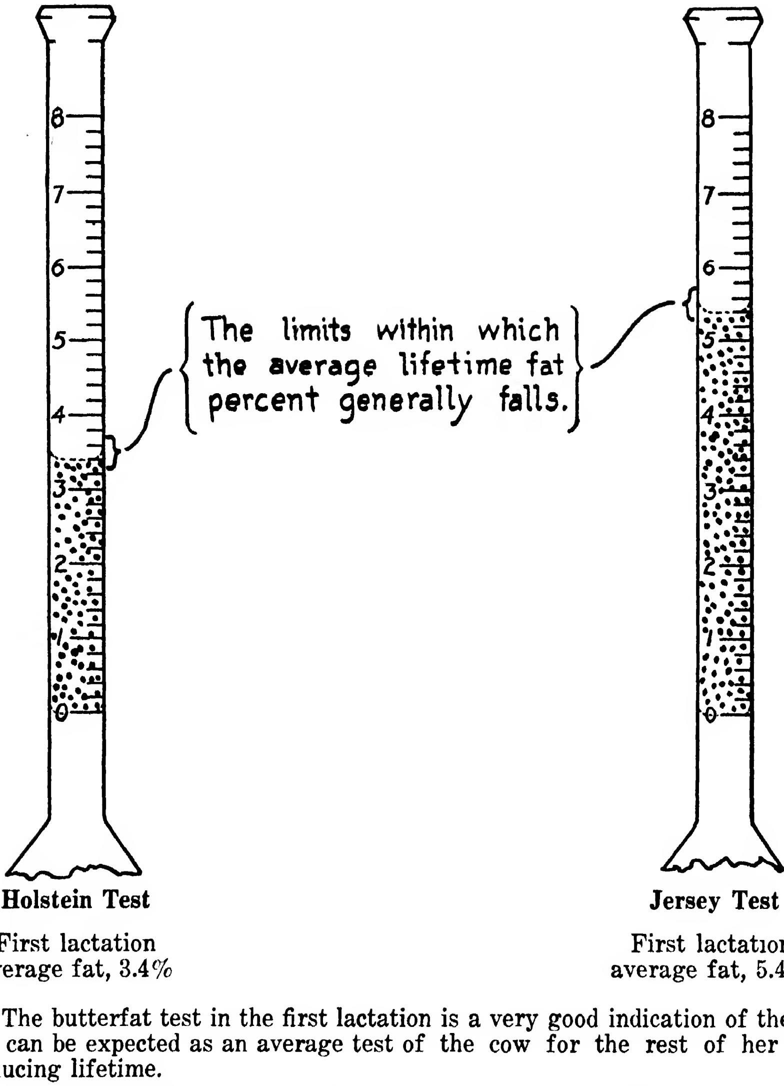

Holstein Test

First lactation
average fat, 3.4%

Jersey Test

First lactation
average fat, 5.4%

The butterfat test in the first lactation is a very good indication of the test that can be expected as an average test of the cow for the rest of her milk producing lifetime.

Butterfat percentages for individual lactations show differences as high as 0.9 percent for Holsteins and 1.1 percent for Jerseys. The average difference for the 32 Holstein records studied was 0.36 percent and for the 30 Jersey records 0.57 percent.

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BUTTERFAT TESTS OF FIRST AND LATER LACTATIONS

The Average Test of First Lactation Proves a Good Indication of Lifetime Average Test

C. F. MONROE

In herds where milk and butterfat records are kept the first lactation period for each animal really amounts to a probation. If the cow proves to be a poor or only a fair producer the sooner she is replaced by a more profitable animal the better. However, it is not always easy to predict the future production of any cow; and sometimes a cow may be satisfactory from the standpoint of the amount of milk which she produces but unsatisfactory because of a low average test. With milk selling on a butterfat basis or where cream is sold, the butterfat production is just as important as the milk production. Hence, the question is frequently asked, "How will the fat test for the first lactation compare with the average test for the cow's milk-producing life?" See "Tests" on opposite page.

In the records kept by the Experiment Station there is material that will throw some light on this question. It has been the practice of the Dairy Department to weigh and sample the milk given by each cow at every milking. Composite samples of milk from each cow are then tested four times a month. In this way an accurate butterfat test for all the milk produced by each cow is obtained.

This study includes the records of 32 Holstein and 30 Jersey cows that have completed four or more lactations in the Station dairy herd. In making this study, the records of all the cows completing four or more lactations have been included, with the exception of a few individuals in the herd at its beginning. These were omitted because the butterfat tests were not given for the first lactation. The 62 cows have not all been fed or treated alike. The

results, therefore, cover a wide range of feeding conditions, some of which we know have not been the most conducive to high fat tests. On the other hand, the Experiment Station herd has not been subjected to the hardships of extreme mistreatment, such as allowing the cows to gain a living by eating frozen corn stalks or forcing them to get the best they could out of a dried-out pasture. It is believed that the conditions under which the herd has been kept may be called average.

The tests as given in Table 1 are from milk yields varying from approximately 4,000 to 22,000 pounds. The butterfat percentages were obtained by dividing total pounds of fat by total milk produced.

Comparing the tests for the first lactations and the average tests as indicated in the table, it is noted that there is a slight tendency for the first tests to be higher. This occurred in 19 out of the 32 Holstein records and in 19 of the 30 Jersey records. However, for the most part the degree of variation between the first lactation test and the average tests was not great. For Holstein cows, 19 of these first tests were within 0.1 percent (either under or over) of the test for life. A variation of 0.2 included 28 of the records, and of the remaining four, two showed a difference of 0.21, one of 0.45, and one of 0.40 percent.

In the Jersey records a variation of 0.1 percent (either under or over) includes 14 of the 30 cows and a variation of 0.2 includes 22 records. Of the remaining 8, 3 varied less than 0.3 percent, 3 less than 0.4, and the other 2, 0.44 and 0.69, respectively.

It was extremely seldom that the first test was much lower than the average test for life. One Holstein cow tested 0.45 percent less in her first lactation than she did in the rest of her milk-producing life. The first test of one Jersey was 0.69 percent lower than her life average. It seems significant that, barring these two instances, no cow's first test was lower than her average test by more than 0.2 percent; and indeed there were only four of the 60 remaining records that approached this figure.

In general, it may be said that in the Station herd the test a cow made in her first lactation was a very good indication of the test that could be expected from her during the remainder of her milk producing life. From the consistency of the relationship here found even under widely differing conditions of feeding, we would expect the same relationship to exist very generally in other herds. As a matter of fact, Gowen of the Maine Agricultural Experiment Station in his book on Milk Secretion has shown that this is true.

TABLE 1.—Butterfat Percentages of First Lactations and Average of Lifetime Compared

Cow	Lactations	Average test		Difference	Average yearly test		Difference
		First lactation	Lifetime		Highest	Lowest	
No.	No.	Percent	Percent	Percent	Percent	Percent	Percent
			32 Holstein records				
33	7	3.32	3.20	+.12	3.32	3.12	.20
35	4	3.20	3.03	+.17	3.20	2.91	.29
52	5	3.67	3.71	—.04	3.85	3.63	.22
55	5	3.32	3.17	+.15	3.32	3.04	.28
57	11	3.47	3.45	+.02	3.92	3.47	.45
59	9	3.32	3.13	+.19	3.32	3.01	.31
63	5	3.09	3.19	—.10	3.34	3.07	.27
65	8	3.05	2.84	+.21	3.05	2.69	.36
66	6	3.61	3.63	—.02	3.78	3.43	.35
67	4	3.98	4.04	—.06	4.13	3.98	.15
70	7	3.33	3.40	—.07	3.59	3.24	.35
76	6	3.21	3.25	—.04	3.34	3.20	.14
79	4	3.01	2.98	+.03	3.08	2.79	.29
90	8	3.78	3.71	+.07	3.91	3.51	.40
92	10	3.38	3.31	+.07	3.53	2.98	.55
104	5	3.29	3.34	—.05	3.59	3.23	.36
107	8	3.34	3.50	—.16	3.69	3.34	.35
109	5	3.35	3.40	—.05	3.49	3.34	.15
110	5	3.09	3.29	—.20	3.60	3.09	.51
111	7	3.33	3.26	+.07	3.40	3.18	.22
121	8	3.47	3.40	+.07	3.55	3.15	.40
124	6	3.80	3.70	+.10	3.79	3.46	.33
146	8	3.75	3.71	+.04	4.04	3.26	.78
154	8	3.80	3.40	+.40	3.80	3.09	.71
161	4	3.15	3.19	—.04	3.28	3.06	.22
163	7	4.10	3.99	+.11	4.31	3.82	.49
170	7	3.53	3.47	+.06	3.67	3.23	.44
197	4	3.23	3.24	—.01	3.36	3.15	.21
203	4	3.30	3.26	+.04	3.35	3.20	.15
216	5	3.02	3.47	—.45	3.91	3.02	.89
236	4	3.98	3.77	+.21	3.98	3.66	.32
244	4	3.78	3.61	+.17	3.85	3.51	.34
Average	....	3.44	3.41	....	....	....	.36
			30 Jersey records				
41	5	5.74	5.74	0	5.82	5.68	.14
42	11	5.74	5.56	+.18	5.83	5.01	.82
44	7	5.25	5.33	—.08	5.95	5.02	.93
47	8	5.93	5.58	+.35	6.18	5.15	1.03
53	8	5.03	4.80	+.23	5.08	4.66	.42
56	4	5.73	5.41	+.32	5.73	5.26	.47
61	5	5.77	5.85	—.08	6.66	5.56	1.10
62	4	5.16	5.15	+.01	5.20	5.07	.13
64	6	5.06	5.08	—.02	5.36	4.87	.49
68	6	5.01	4.89	+.12	5.01	4.73	.28
69	[illegible]	5.82	5.56	+.26	5.82	5.36	.46
80	4	4.94	4.90	+.04	4.94	4.81	.13
87	4	5.61	5.88	—.17	6.27	5.53	.74
96	6	5.30	5.28	+.02	5.52	5.08	.44
101	4	5.41	5.29	+.12	5.41	5.23	.18
105	6	5.78	5.34	+.44	5.78	5.00	.78
106	6	5.28	5.22	+.06	5.29	5.04	.25
112	8	5.18	5.08	+.10	5.29	4.76	.53
119	8	5.34	5.33	+.01	5.55	5.07	.48
127	8	4.76	4.88	—.12	5.15	4.25	.90
128	7	5.73	5.42	+.31	5.73	5.25	.48
142	4	5.11	4.98	+.13	5.22	4.71	.51
143	5	5.59	5.33	+.26	5.59	5.00	.59
147	6	5.07	5.10	—.03	5.36	4.84	.52
159	6	4.94	5.63	—.69	5.98	4.94	1.04
162	5	5.14	5.26	—.12	5.63	5.14	.49
173	5	5.60	5.67	—.07	6.00	5.28	.72
206	4	5.87	6.03	—.16	6.50	5.77	.73
215	5	5.40	5.39	+.01	6.06	5.05	1.01
242	4	5.52	5.46	+.06	5.59	5.20	.39
Average	....	5.40	5.35	....	....	....	.57

+ Denotes first lactation test higher, and —lower, than average lifetime test.

What has been said applies to butterfat percentage; it must not be confused with the total milk and butterfat production. The total milk and fat produced in the first lactation (approximate age, 2 years 2 months) is generally considered to be about 70 percent of what may be expected of the cow under like treatment at maturity (7 years).

So far only the relation between the tests for the first lactation and the average lifetime tests has been considered. What has been said about this relationship must not be taken to mean that the butterfat test for each cow's milk is uniform from lactation to lactation. The highest and lowest testing lactations for each cow, and the difference between these extremes are also shown in Table 1.

Table 2 brings out more clearly just how these tests fluctuated. This table shows the number of Holsteins and Jerseys that varied in their butterfat tests less than 0.1 percent, between 0.1 and 0.2 percent, and so on up to 1.1 percent. It will be noted that 4 of the Jersey cows showed variations of 1 percent and over, while an equal number never had variations of more than 0.2 percent. The Holstein cows did not show as large variations as the Jerseys. The largest difference noted for the Holsteins was 0.9 percent, while there were 5 that never showed a variation greater than 0.2 percent.

The average variations for the Holsteins was 0.36 and that for the Jerseys 0.57 percent.

Of course, these differences in tests represent a comparison between extremes. They are not the differences that ordinarily occur from lactation to lactation, but rather represent the extremes of tests which may be expected during the lifetime of an individual. No relationship could be found between the different lactations and either high or low butterfat tests, with this exception, that when either extreme of test occurred in the first lactation the difference between the extremes was not great. These fluctuations plainly show that the butterfat content of a cow's milk is not uniform, even when the entire lactation is considered. In other words, a 4 percent cow is not always a 4 percent cow.

TABLE 2.—Variations in Butterfat Between the Highest and Lowest Testing Years, Showing Number of Cows in Each Group Varying From—

	0 to .1	.1 to .2	.2 to .3	.3 to .4	.4 to .5	.5 to .6	.6 to .7	.7 to .8	.8 to .9	.9 to 1.0	1.0 to 1.1	Total
Holstein	0	5	8	9	5	2	0	2	1	......	......	32
Jersey	0	4	2	1	8	4	0	4	1	2	4	30

LEGUMES PLOWED DOWN FOR CORN

Sweet Clover Gave Larger Increases of Corn and Oats Than Red or Mammoth Clover in Paulding County Tests

J. S. CUTLER AND H. R. HOYT

The plowing down of legumes forms a foundation for high yields of corn. Most of the recent record yields of corn were made where a legume immediately preceded corn in the rotation.

A comparative test of the value of the different legumes for plowing down has been conducted for the past nine years on the Paulding County Experiment Farm. Both a two-year rotation of corn, oats (legume plow down crop) and a three-year rotation of corn, oats, and legume hay have been used. The tests are of sufficient duration to indicate the relative results which may be secured from the different legumes tested. The crops received no manure nor fertilizers.

The soil is a heavy phase of Brookston clay locally known as "Paulding clay." The surface soil is dark gray to gray-black. The natural drainage is poor, requiring tiling for successful crop production.

TABLE 1.—Effect of Plowing Down Different Legumes on Yield of Succeeding Corn and Oats Crops

Rotation: Corn, oats, (legume plow down crop)

Plot		Corn, bushels per acre					Average increase for legume
		1918	1920	1922	1924	Average	
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
7	No legume....................	27.1	47.4	28.6	22.1	31.3	....
8	Medium red clover...........	37.1	46.4	49.4	36.4	42.3	11.0
9	Biennial white sweet clover ..	42.8	53.3	58.4	42.9	49.4	18.1
10	Mammoth clover	30.0	42.8	44.4	37.1	38.6	7.3

Plot		Oats, bushels per acre					Average increase for legume
		1919	1921	1923	1925	Average	
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
7	No legume....................	57.8	22.9	35.0	47.8	40.9	....
8	Medium red clover...........	48.1	25.9	41.2	58.7	43.5	2.6
9	Biennial white sweet clover ..	48.7	34.0	53.1	63.6	49.9	9.0
10	Mammoth clover	53.1	25.4	46.9	53.7	44.8	3.9

Biennial white sweet clover seeded with oats and plowed down for corn the following spring gave an 18 bushel increase (Table 1) in the corn and a 9 bushel increase in the oat yield. These increases are nearly double those secured from either medium red or mammoth clover. The sweet clover has made a difference in the soil: it is easier to work, has become more friable, and appears to dry out faster in the spring where sweet clover was plowed down. This difference is not as noticeable with other legumes, altho it is quite apparent that the plowing down of a legume crop has somewhat improved the physical condition of the soil. There was only a slight difference between medium red clover and mammoth clover for soil improvement on this soil.

TABLE 2.—Effect of Legume on Succeeding Crop Yields

Rotation: Corn, oats, legume hay

Corn: bushels per acre					
Plot		1919	1922	1925	Average
11	Medium red clover	46.6	62.1	84.7	64.5
12	Biennial white sweet clover	61.3	64.3	86.9	70.8
13	Mammoth clover	49.3	51.7	83.1	61.4
Oats: bushels per acre					
Plot		1920	1923	1926	Average
11	Medium red clover	45.0	36.2	58.2	46.5
12	Biennial white sweet clover	57.8	48.7	58.7	55.0
13	Mammoth clover	54.3	31.9	56.5	47.6
Hay: tons per acre					
Plot		1918	1921	1924	Average
11	Medium red clover	0.84	1.64	3.20	1.9
12	Biennial white sweet clover	1.38	1.19	....	1.3
13	Mammoth clover	1.54	2.85	1.66	2.0

A further comparison of the legumes tested is given in Table 2. Here the legumes were grown in a three-year rotation of corn, oats, and a legume hay. The stubble and fall growth remaining on the ground were plowed under the following spring for corn. Sweet clover gave an increase of 6.3 bushels of corn and 8.5 bushels of oats above the yields secured from medium red clover, and 9.4 bushels of corn and 7.4 bushels of oats above mammoth clover. The hay yields are not comparable. The mammoth clover lodged so badly in 1924 that it was impossible to secure all the hay and the sweet clover became so coarse and woody because of the wet weather that satisfactory hay could not be made.

SUGGESTIONS ON THE METHOD OF PRODUCING SEED POTATOES

JOHN BUSHNELL AND P. E. TILFORD

Only a small proportion of the certified seed planted each year in Ohio is produced within the State. The small group of growers who, with the cooperation of the State Department of Agriculture, are certifying seed, have encountered numerous discouragements in maintaining disease-free seed stocks, and have faced particular difficulties in the control of degeneration diseases. The methods that have been recommended and generally followed have proved to be inadequate. The problem has been studied at the Experiment Station for a number of years and, as a result of this work, a few suggestions are offered at this time.

Leafroll plant on left. Healthy plant on right. Irish Cobbler variety

The diseased plant shows the characteristic rolling of the leaflets, but no dwarfing. When the leaflets of healthy plants are rolled from hot weather, the diseased and healthy plants look much alike, and it is then impossible to rogue effectively.

These studies show that the present problem faced by the seed producers is largely one of leafroll control. In comparative tests with certified seed from northern states, disease-free samples of Ohio seed have yielded as well as the northern grown seed. See

Note: The Experiment Station does not certify seed potatoes. Any communication in regard to certification standards or available stocks of seed should be addressed to Secretary, Ohio Certified Seed Potato Growers' Association, Ohio State University, Columbus.

Table 1. The Ohio climate, itself, has not been detrimental to the quality of the seed. But many of the Ohio samples have shown a considerable proportion of hills infected with leafroll and the yield has usually been reduced accordingly. The disease counts on the samples tested during 1926 is given in Table 2. Leafroll, which is one of the degeneration diseases, was more serious in the 1926 test than all other diseases combined. The difficulty in controlling leafroll arises from the fact that it is practically impossible to detect and remove all of the infected hills from a field which is being grown for seed purposes.

TABLE 1.—Comparison of Yield of Disease-free Seed Potatoes From Different States*

Bushels per acre

Year	Ohio		Michigan	New York		Wisconsin
	Sir Walter Raleigh	Russet Rural	Russet Rural	White Rural	Russet Rural	White Rural
1925	185	191	165	154	150	145
1926	204	203	208	243	205	....
Average	195	196	187	198	178	....

*Including all lots with less than 1 percent of diseased hills.

Characteristics of leafroll.—Typically, leafroll produces not only a rolling of the leaves, but a somewhat upright growth and more or less dwarfing of the plant. In mild cases only a slight rolling may occur, and the diseased plants are difficult to separate from healthy plants that become rolled from the heat and drouth of summer. The disease has a long incubation period before the symptoms can be detected in the leaves, and during this period the tubers become infected. It survives over winter in the infected tubers, but it cannot be detected by examination of the tubers during storage nor controlled by any seed treatment. A more detailed description of leafroll is given in the Bimonthly Bulletin of March-April, 1926.

Insect transmission.—During the growing season the virus, or causal agent, of leafroll is carried from infected to healthy plants by aphids and possibly by leafhoppers. These insects are abundant in Ohio potato fields, and climatic conditions seem especially favorable for the distribution of the virus by them. The disease, therefore, is spread more rapidly under Ohio conditions than in the North. As yet, no practical method of spraying or dusting has

been developed which will completely eradicate these insect carriers. If diseased plants are present in the field, the virus is almost certain to be spread.

Roguing inadequate.—Removal of diseased plants has been largely relied upon to control leafroll in Ohio as elsewhere. In the northern states, persistent roguing has been highly successful in controlling virus diseases. In Ohio, because mild cases of leafroll are more difficult to detect, and because of the rapid rate of spread, the method has been inadequate. In certain sections of New York, according to Stewart, N. Y. Exp. Sta. (Geneva) Bul. 522, similar difficulty has been encountered. Roguing has failed to control this elusive virus disease in our climate.

TABLE 2.—Leafroll and Other Diseases in 150-Hill Rows of Certified Seed

Produced in	Variety and sample		No. of leafroll	Diseased hills other diseases*	Yield, bushels per acre
Ohio	Sir Walter Raleigh	A	0	0	216
		B	0	0	191
		C	10	0	172
	White Rural	D	12	1	210
	Russet Rural	E	0	0	203
		F	58	0	144
		G	51	0	175
		H	27	0	189
	Average				187
New York	White Rural	A	0	0	240
		B	0	2	246
		C	17	0	132
	Russet Rural	D	1	0	205
		E	5	0	173
		F	7	2	188
	Average				187
Michigan	Russet Rural	A	0	0	219
		B	0	1	209
		C	0	0	196
	Average				208

*Includes Black-leg, Yellow-dwarf, Mosaic, and Rhizoctonia.

Disease-free foundation stock.—Experimental results show that leafroll is carried over winter in the seed tubers, and very little if any infection comes from any other source. The first step in producing certified seed in Ohio, therefore, is to secure a seed stock free from leafroll. Fortunately, foundation stocks free from virus diseases, or practically so, can be obtained. As a result of the comparative certified seed tests at the Experiment Station, we are recommending that foundation stock be procured from those

growers in Ohio and Michigan whose samples have shown no degeneration diseases in the tests of the past three years. The names of these growers will be furnished upon request.

Isolation of seed plot.—After a satisfactory foundation stock has been secured, it is obvious that all possible precautions must be taken to avoid infection during the growing season. The insects which transmit the virus diseases migrate from plant to plant, hence carry infection from diseased to healthy fields. The certified seed plot then should be isolated as far as possible from any diseased potatoes.

The exact distance that insects may carry the virus is not known. The distance undoubtedly varies with the abundance of insect carriers and with climatic conditions. No rigid recommendation as to the distance between the seed plot and other potatoes can be made at this time. The certified seed field should be as far as possible from other potatoes, and under no circumstances should other potatoes be adjacent to it.

Disease-free soil.—The survival in the soil of the causal agent of the virus diseases is not a serious source of infection. However, other diseases, such as Fusarium, Rhizoctonia, and Scab must also be controlled by the certified seed producer. These diseases survive in the soil to a dangerous degree, therefore the recommendation that potatoes grown for certification should not be on soil that has recently grown potatoes is sound and should be followed.

In spite of all precautions, these diseases occasionally appear, and it is necessary to remove diseased hills as soon as they are detected. To rogue intelligently and efficiently the certified seed grower must acquaint himself with the symptoms of the various potato diseases. An understanding of potato diseases and the methods of dissemination and control is practically indispensible to the successful producer of certified seed potatoes in Ohio. (See Ohio Experiment Station Bulletin 374 for descriptions of potato diseases).

Conclusion.—Roguing out diseased hills has not proved an adequate means of maintaining certified seed potatoes satisfactorily free from the leafroll disease in northern Ohio. Hence, if high grade certified seed is to be grown in Ohio, it is necessary to supplement roguing by securing a foundation stock free from leafroll and related virus diseases, and to take special precautions to prevent infection from neighboring potato fields.

CONTROL OF DAMPING-OFF IN CONIFEROUS SEED BEDS

CURTIS MAY AND H. C. YOUNG

The disease of coniferous seedlings known as "damping-off" is one of the important factors limiting their successful propagation in many forest nurseries. Losses from this disease occur almost every season, and, if weather conditions are favorable during the susceptible age of the seedlings, more than half the stand may be killed. While the destruction is most noticeable during the early life of the seedlings, the same fungi responsible for the early losses frequently kill the young plants later in the season.

Normal type of the disease.—The symptoms of damping-off are generally well known, so a brief mention of them here will suffice. The disease is usually first noticed in the beds when some of the seedlings either bend over or fall on the ground. Close inspection usually reveals a constricted and discolored area on the stem of a diseased plant near the ground. Damping-off infections are not always at or near the soil surface. Sometimes the seedlings show no lesion above ground. However, if the roots are scrutinized, a brownish discoloration will be evident. Young plants from the time they appear above ground until the stems begin to get woody, will succumb to these two symptomatic types of damping-off.

Seedlings may be attacked as soon as they burst thru the seed coat, and it is not improbable sometimes that seed accused of poor germination sprouted, but the sprouts were killed before they came above ground. Such early infections by damping-off fungi may entirely escape notice unless they are specifically looked for.

Late type of the disease.—The losses caused by damping-off fungi early in the life of the plant may be augmented later by another type of the disease sometimes called "seedling blight". Unlike the commonly recognized damping-off, the plants in this case do not fall over, but remain erect. They are usually smaller than neighboring healthy plants, and are paler. As the fungus develops within the roots the tops dry up and turn brown. Diseased seedlings can readily be lifted from the soil, for much of their root system has been destroyed. It is rather important to recognize that this type of injury is essentially of the same nature as the more commonly known type and that the control methods applicable to one are equally applicable to the other.

Cause of damping-off.—The two most important fungi causing damping-off are *Corticium vagum* (Rhizoctonia) and *Pythium de Baryanum*. A species of fusarium sometimes causes damping-off but in the work which is reported upon in this paper it has not been as important as the other two.

These fungi are organisms that survive from year to year in the soil. They are not specific parasites of coniferous seedlings but attack many kinds of young plants. Because of their omnivorous character both Corticum (Rhizoctonia) and Pythium may be present in almost any soil. Consequently, damping-off may occur in beds located where conifers have not been grown previously.

Control.—Since the parasites concerned in damping-off are soil inhabiting, any treatment to be successful must destroy the fungi in the soil. Both greenhouse and field experiments were made with red pine (Pinus resinosa) to determine the best method of application and relative value of sulphuric acid, sulform, formaldehyde, and several organic mercury compounds. The results are tabulated as follows:

TABLE 1.—Experiments on Soil Treatments for Damping-Off Of Red Pine Seedlings

Material used	Treatment	Plot	Year	Total plants	Plants damped-off	
		No.		*No.*	*No.*	*Pct.*
Sulphuric acid	1 oz. per gal. of water per 4 square feet of bed	1	1924	805	251	31
		2*	1925	112	11	10
		3*	1926	89	29	24
Check	Not treated	4	1924	720	309	43
		5	1925	286	26	9
		6	1926	1,648	376	22
		7*	1925	101	20	20
		8*	1926	120	35	29
Formaldehyde	3 % solution, 1 quart per 2 square feet of bed	9	1924	910	120	13
		10	1925	41	0	0
		11	1926	1,283	20	1.5
Sulform	A. As formaldehyde	12	1924	885	75	8.5
	B. 2½% at planting time	13	1924	751	190	25
Uspulum	A. 0.25% solution at planting time, 1 quart per 1 square foot of bed	14	1924	745	126	17
	B. Two treatments, one as above, other when seeds sprouted	15	1925	220	26	12
		16*	1926	85	34	40
Semesan	0.25% at planting time, 1 quart per square foot of bed	17	1924	895	139	15.5
		18	1925	197	4	2
		19*	1925	110	14	12

*Plots marked with star are greenhouse experiments.

The results recorded in the table show that the formaldehyde treatment for controlling damping-off was distinctly superior to any of the other treatments. Under the conditions of the experiments, the organic mercury compounds which were used did not give satisfactory control.

In addition to the materials listed in the table, Kalimat, Abavit, Wa Wa dust, and colloidal copper hydroxide were tested, but they did not control the disease. Sodium silico fluoride and sodium acid fluoride applied to the soil at the rates of 26, 39, 52, and 78 grams per 2 sq. ft. of plot before the seeds were planted were distinctly injurious to germination, from 0 to 35 seeds sprouting when the comparable checks averaged 120. Furthermore, as high as 37 percent of the seeds that sprouted damped-off.

Sulphuric acid has been successfully used on certain types of soil by some investigators but it could not be applied to the beds in the experiments because it injured germination.

Formaldehyde treatment.—The beds should be prepared up to the point of seeding just as if no treatment were to be given. Then the formaldehyde solution is sprinkled on the beds.

A 3-percent solution is recommended for most soils. On light soils the strength of the disinfectant may be slightly reduced. A gallon of solution will cover 6 to 8 sq. ft. of bed, depending upon the type of soil and the amount of water present in it when the treatment is made.

Immediately following the treatment the beds should be covered with burlap, paper, or canvas, to retain the gas released by the formaldehyde solution. The covering, which retards the escape of gas, should remain on the beds at least two days to obtain the maximum fungicidal value. When the cover is removed, sufficient time must be allowed before seeding to permit the formaldehyde to escape from the soil. In most cases the soil will be aerated in two to five days.

It is vital to note that, altho the treatment may kill all the parasitic fungi in the soil at the time, it does not prevent their reintroduction later on shoes and tools or other accessories used about the beds. All possible precautions should be exercised to prevent the reestablishment of the parasites in the treated beds.

THE SOILS OF THE GLACIAL LAKE REGION OF NORTHEASTERN OHIO

G. W. CONREY

The glacial lake plain in Ohio includes a narrow belt bordering Lake Erie in northern and northeastern counties and a broad area in northwestern Ohio, extending to the State line in Paulding County. The present discussion is confined to the area in north-eastern Ohio, east of central Erie County. Here the lake plain varies in width from 4 to 20 miles with an average of less than 10 miles.

Origin of the soils.—Toward the close of the glacial period as the ice melted from the area which we now know as Ohio, the waters, failing to find an outlet to the south, began to accumulate over northern Ohio and formed a great lake extending as far west as Fort Wayne, Indiana. This lake existed for a sufficient length of time to form a gravelly beach ridge which today marks its limits.

Area of the glacial lake soils of northeastern Ohio

The recession of the water from the highest lake level to that of the present Lake Erie took place in several stages. This is shown by a succession of beach ridges, each marking the extension of the lake during that particular stage. The stage of greatest extent is known as Lake Maumee, while Lake Whittlesey and Lake Warren are names applied to later stages.

During the existence of these lakes material was carried into them by streams, just as it is being carried into Lake Erie today. This was assorted by the water and the coarse portions were left near the borders of the lake as beach and other sandy near-shore deposits. The fine material was carried into deeper water and dropped down as laminated silts and clays. Over much of the lake

bottom, however, there is very little evidence of such quiet water deposits, the surface material being glacial drift deposited before the lakes covered the region. Only locally are the fine textured lake deposits of considerable depth. Altho a maximum thickness of 28 feet has been recorded, this is exceptional, for such deposits are seldom over 10 to 15 feet in thickness. A thin veneer of sandy material in the form of low knolls in places rests on the glacial drift, giving rise to more or less isolated sandy areas. It is only adjacent to the old lake beaches that coarse lacustrine deposits are at all extensive.

The character of the material carried into the lake is closely related to the nature of the surrounding uplands within the drainage basin of the streams flowing into the lake. East of Sandusky the surface deposits are largely derived from sandstone and shale, whereas to the west the parent material is predominantly limestone. It is with the region largely of sandstone and shale derivation, that the present discussion is concerned.

Into this lake plain streams have cut valleys, which are the sites of alluvial deposits, some as first bottom lands, subject to overflow, some as second bottoms or terraces.

The soils of the region have resulted chiefly from the weathering of these lacustrine or lake-laid and glacial or ice-laid deposits. Since these materials were deposited near the close of the glacial period, the time during which they could weather has been relatively short, hence the soils of the region are for the most part young soils, as far as soil development is concerned. Moreover the very wet, poorly drained condition of much of the region has tended to retard the normal processes of weathering and soil development.

Topography and drainage.—The old beach ridges which continue for miles are the most striking topographic feature of the region. They are commonly 150 to 200 yards wide and rise 20 or 40 feet above the adjacent lake-plain. These high-lying areas, which are well drained because of their gravelly nature, were the sites of the first roads and houses in the region. Many of the leading highways of the region follow these old beach ridges.

In contrast to these ridges is the level lake-plain which in places is almost floor-like. These areas are naturally poorly drained. The surface of portions of the lake-plain is broken by low knolls and irregular ridges which usually are sandy, and give a gently undulating topography.

SOILS OF THE GLACIAL LAKE REGION OF NORTHEASTERN OHIO

A. Lacustrine Soils

The deposits laid down by the glacial lakes have weathered under various conditions of topography and drainage to produce the different soils of the region. As is characteristic of such deposits, the soil-forming material usually shows a high degree of assortment. The well drained beach and other sandy deposits, which have existed under conditions giving good aeration, have weathered to give light colored soils. The poorly drained sandy and heavy deposits have weathered under conditions favorable for the accumulation of organic matter, resulting in the development of dark colored soils.

Based on color and certain other differences in the soil profile, these soils have been grouped into a number of series.*

Chenango series, beach ridge phase.—These soils have yellowish-brown to brown surface soils and yellowish-brown subsoils. The substratum, which occurs at 20 to 40 inches, consists of stratified sand and gravel, made up largely of material derived from sandstone and shale, which formations make up the bedrock of the region. In places the gravels are cemented with calcium carbonate. Limestone pebbles are exceedingly rare.

These soils are on long narrow ridges, which are the old beaches of the glacial lakes that once occupied the region and were deposited by waves on the old lake shores. They have excellent drainage, due to their topographic position and the gravelly nature of the lower subsoil. Fruit and vegetables are important crops. Chenango fine sandy loam, beach ridge phase, is an important type.

The Plainfield series has light yellowish-brown to grayish-brown surface soils, yellow upper subsoils, and pale yellow lower subsoils. The lower subsoil is invariably sandy to considerable depth, commonly 10 feet or more. In the lake-plain region of Ohio these soils have an undulating to gently rolling topography. In

*The soils derived from lake-laid deposits in northeastern Ohio differ from those in the northwestern part of the State, chiefly in reaction and in the carbonate content of the substratum. The northeastern soils in general are acid to very acid, the northwestern are neutral to slightly acid. The former may be slightly calcareous below 50 or 60 inches, the latter are commonly highly calcareous at 30 to 40 inches. Only the light colored sands in the two areas have been classified in the same series. The following table shows the relation between the series of lacustrine soils in northeastern and northwestern Ohio:

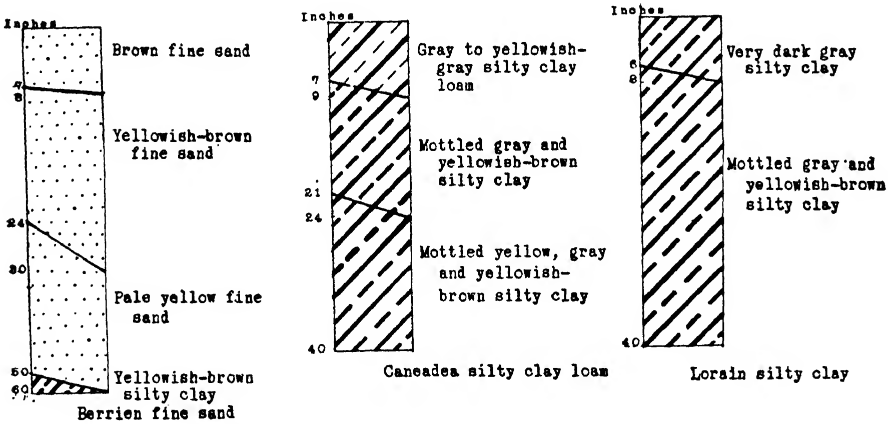
Northeastern Ohio	Northwestern Ohio
Chenango, beach ridge phase	Fox, beach ridge phase
Plainfield	Plainfield
Berrien	Berrien
Painesville	Lucas
Caneadea	Fulton
Reynolds	Wauseon
Lorain	Toledo

places, as a result of wind action, these soils occupy a dune-like surface. The drainage is good to excessive, there being a tendency toward droughtiness.

Plainfield fine sand* is the most important type. This soil occurs in small areas in many parts of the lake-plain.

The Berrien series includes sandy soils which have gray-brown surface soils, and yellow upper subsoils. Below about 24 inches the subsoil is pale yellow. At 50 to 60 inches the sand rests on heavy layers usually a silty clay loam to silty clay. For a few inches above the heavy layer there may be faint mottlings. This series differs from the Plainfield in the depth of the sand deposit, the Berrien being less than 5 feet, the Plainfield commonly 10 feet or more. The presence of a heavy substratum at moderate depths increases the soil moisture supply very decidedly.

These soils have an undulating to gently rolling topography. Low isolated knolls are common. The natural drainage is good. Berrien fine sand is an important type.



Berrien fine sand — Caneadea silty clay loam — Lorain silty clay

Painesville series includes soils with grayish-brown to brown surface soils and yellowish-brown subsoils. At a depth varying from 20 to 40 inches the lower subsoil becomes quite heavy, usually a silty clay which may be slightly calcareous below 50 or 60 inches. The laminated nature of the slack water deposit is still in evidence below 40 or 50 inches. The topography is level to gently undulating and the surface drainage good. The underdrainage is fair to good. Painesville very fine sandy loam and silt loam are important types.

Caneadea series.—The surface soils of this series are gray to brownish-gray. The upper subsoils are mottled gray and yellowish-

*In former reports this soil has been called Dunkirk fine sand.

brown, while below 20 or 24 inches the color is mottled yellowish-brown and yellowish-gray with rust brown spots. The lower substratum is usually quite heavy in texture, and below 40 or 50 inches shows laminations characteristic of a slack water deposit. The topography is level and the natural drainage poor. Caneadea silty clay loam and silty clay are important types.

The Reynolds series includes soils of a sandy nature which have a dark gray to grayish-black surface soil. The upper subsoil is mottled yellowish-brown and gray. The lower subsoil as well as the substratum is a heavy clay, which may be slightly calcareous below 50 or 60 inches. The sandy material is probably of lacustrine origin, the underlying substratum may be either heavy lacustrine deposits or glacial drift. The topography is level and the natural drainage poor. Reynolds fine sandy loam is the most important type.

Lorain series.—The surface soil of the Lorain series is dark gray. The upper subsoil is bluish-gray streaked with yellow. The lower subsoil is mottled yellow, yellowish-brown and gray. There is no marked change in texture within the soil profile, altho the material shows stratification, characteristic of fine textured lacustrine deposits. The topography is level and the natural drainage very poor. Lorain silty clay loam and silty clay are important types.

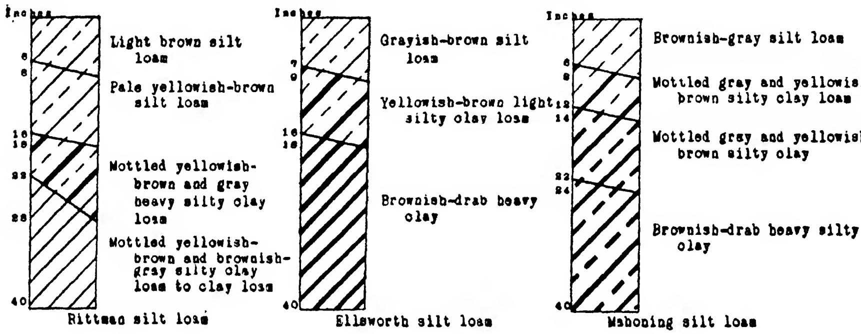
Included in the Lorain series is the dark-colored phase which is very limited in extent. The surface is a very dark gray to gray black. The subsoil is similar to that of the typical soil, except that as a result of poorer natural drainage it does not have as much yellow in the mottling as does the typical soil. This phase commonly is a gradation toward organic soils such as muck and peat. The topography is flat and the natural drainage poor. Lorain silty clay loam, dark colored phase, is one of the more important types.

Wickliffe series.—The surface soil is yellowish-gray, underlain by a mottled-gray, yellowish-gray and brownish-yellow subsoil which invariably is very heavy in texture. Bedrock, which is a dark shale, exists at a depth ranging from 36 to 80 inches. These soils are very acid thruout the soil profile, the acidity increasing with depth. The topography is level and the natural drainage poor.

The Wickliffe soils are of very limited extent. They exist in areas with a shallow covering of soil over the heavy shale beds which outcrop along the shore of Lake Erie and come near the surface for some distance south from the Lake. Wickliffe silty clay loam and silty clay are the chief types.

B. Deep Glacial Soils

Soils of glacial origin are closely associated with the lacustrine soils in northeastern Ohio. The lake-plain is everywhere narrow, hence the region of glacial soils exists only a few miles south of Lake Erie. Thruout the lake-plain there are areas where the glacial drift has not been covered by lacustrine deposits. In such locations the soils are glacial in origin as are those to the south beyond the borders of the lake-plain. These soils are commonly very heavy in texture, being derived from glacial drift made up in a large part of shale material. Only the more important glacial soils of the region are described in this outline.*



Rittman series.—The surface soil of this series is a light brown to grayish-brown and the subsurface a pale yellowish-brown. The upper subsoil from 16 to 24 or 30 inches is much heavier than the soil above, and rather compact and impervious. In the Rittman silt loam the texture is a heavy silty clay loam, and the color is mottled yellowish-brown and yellowish-gray. The lower subsoil is lighter in texture and more friable, consisting of a gravelly clay loam to light silty clay loam, which is noncalcareous to at least four feet. It is not uncommon for the glacial drift to be slightly calcareous below five feet, however this condition is not so pronounced as in the Ellsworth and Mahoning soils. The upper three feet of the soil is commonly acid in reaction. The topography is undulating to gently rolling, and the surface drainage is good. Because of the tight impervious subsoil the natural underdrainage is only fair, hence could be improved by tiling. The most important type is Rittman silt loam.

The Ellsworth series includes soils with a grayish-brown surface and a yellowish-brown upper subsoil, underlain at 15 to 24

*For a complete discussion of Glacial Sandstone and Shale Soils of Ohio, see the Bimonthly Bulletin, July-August, 1926.

inches by a heavy brownish-drab to olive-drab clay which extends to a depth of 36 inches or more. The lower subsoil below 40 or 48 inches is in places moderately calcareous; the surface soil, however, is generally acid in reaction. These soils have been formed from glacial material derived largely from shale. The topography is gently rolling, and the surface drainage good, but owing to the heavy impervious subsoil, the natural underdrainage is poor. Ellsworth silt loam and silty clay loam are important types.

The Mahoning series includes soils with brownish-gray to gray surface soils and mottled-gray and brownish-yellow subsurface. Below about 15 inches the subsoil is a mottled-gray and yellowish-brown silty clay, which grades into a brownish-drab heavy silty clay. This heavy subsoil extends to a depth greater than 36 inches. Below 40 to 48 inches the substratum is commonly slightly calcareous. Few rock fragments are to be found on the surface or thruout the three-foot soil section. These soils occupy gently undulating areas. The natural drainage is poor owing to the smooth surface and heavy impervious subsoil. Important types are Mahoning silt loam and silty clay loam. Mahoning silty clay loam is one of the types on the Trumbull County Experiment Farm, and on the Northeastern Test Farm at Strongsville.

Trumbull series are soils with light gray to gray surface soils and highly mottled subsoils, colored gray, yellowish-brown, and rust-brown. These soils are commonly very acid. They occupy flat to depressed areas and have poor surface and underdrainage. Many areas are "swampy tracts". On the heavier members of the series tile drainage is difficult owing to the tight impervious nature of the subsoil. Such areas are best adapted to permanent pasture. Trumbull loam, silt loam, and silty clay loam are important types. The silty clay loam is one of the types on both the Trumbull County Experiment Farm and the Northeastern Test Farm at Strongsville.

Chippewa series.—The surface soil of this series is dark gray to grayish-black and the subsoil is mottled bluish-gray, gray, and yellowish-brown. The topography is level and the natural drainage poor. Altho occupying much the same topographic position as a considerable portion of the Trumbull soils, the Chippewa series is not extensive. The chief type is the Chippewa silty clay loam.

C. Shallow Glacial Soils (over sandstone or shale)

Thruout the region there are numerous areas of bedrock, either sandstone or shale, within the subsoil at such shallow depth as to materially modify the agricultural value of the land. Where the

bedrock is within three feet of surface the soils have been included in either the Lordstown or Allis series.

The Lordstown series includes soils with brown surface soils and yellowish-brown subsoils where sandstone or shaly sandstone is within 36 inches of the surface. The soil commonly contains numerous sandstone fragments and bowlders, in fact the subsoil may be in part at least residual from sandstone. The most extensive areas are associated with outcrops of sandstone and conglomerate, which form numerous "ledges" in certain northeastern Ohio counties. These soils are on ridge tops and slopes where the covering of glacial drift is thin. They are naturally well drained, and the shallower areas tend to be droughty. Lordstown stony loam and silt loam are the most extensive types.

Allis series.—The surface soils of the Allis series are brownish-gray and the subsoils are mottled yellowish-gray, gray and yellowish-brown and are very heavy in texture. Shale and shaly sandstone occur at 12 to 36 inches. Sandstone fragments are common on the surface, where the bedrock is mixed shale and sandstone. The topography is commonly gently undulating and the natural drainage poor. Allis silty clay loam is the chief type.

D. Terrace Soils

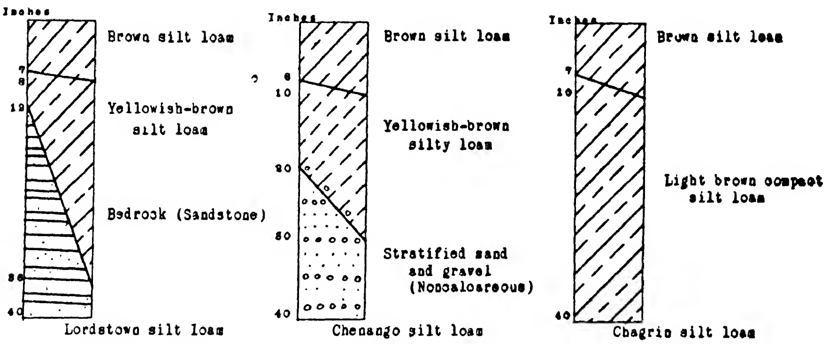
Associated with the upland soils are various terrace or second bottom soils. These are in the valleys of present or former streams and are commonly spoken of as "second bottom lands". They are not subject to overflow, except in extremely high floods. Two groups have been recognized. The first is characterized by layers of stratified sand and gravel in the lower subsoil which were deposited by streams coming from the melting ice that existed in the region during the glacial period. These soils have been included in the Chenango and Braceville series

The second group includes old-stream or alluvial deposits which have been left as terraces or second bottoms as a result of the downward cutting action of more recent streams. The lower subsoils consist chiefly of silt and clay rather than sand and gravel. These soils have been grouped in the Mentor and Tyler series.

Chenango series.—The surface soils of this series are brown, and the upper subsoils are yellowish-brown. The lower subsoil below 20 or 24 inches consists of stratified sand and gravel, in which sandstone and shale make up a large percentage of the coarse material. In places the gravel is coated and sometimes cemented together with calcium carbonate, but limestone pebbles

are exceedingly rare. Chenango soils occupy level to gently undulating tracts and occur as terraces or second bottom. Because of the gravelly substratum the natural drainage is good. In places gravel comes so close to the surface, 10 to 15 inches, as to make the soil droughty. Chenango loam and silt loam are important types.

The Braceville series includes soils with brownish-gray to gray surface soils underlain by a mottled-gray and yellowish-brown subsoil. In the better drained areas the subsurface may be only slightly mottled. The lower subsoil consists of stratified sand and gravel, usually at a depth of 24 to 36 inches. This soil occupies level areas in terraces where the movement of water thru the underlying gravels has been so restricted as to produce poor drainage. The important types are Braceville loam and silt loam.



Mentor series*.—The Mentor soils have brown to grayish-brown surface soils and yellowish-brown subsoils, which are usually somewhat heavier in texture than the surface soils. These soils are essentially free from mottling to a depth of 30 inches or more. The lower subsoil consists of silt and clay. Gravel, if present, is in limited amounts. These soils, on level terraces or second bottoms in old valleys, have been formed by the weathering of stream deposits laid down by slow moving or slack water. The topography is level and the drainage good. Where the subsoil is heavy the underdrainage is fair only. Mentor silt loam is the chief type.

The Tyler series has gray surface soils and mottled subsoils, varying in color from gray to yellowish-brown and rust-brown. The lower subsoil is heavy. The topography is level and the natural drainage poor. The principal types are Tyler loam and silt loam.

*This series was called the Holston in the soil survey reports for a number of northeastern Ohio counties. The name Holston will be used for a somewhat similar soil outside the glacial region.

E. Flood Plain Soils

These soils are first bottom lands and are subject to annual overflow. They have been deposited by the present streams, and are the wash from the surrounding uplands, where the bedrock consists primarily of sandstone and shale. Three series have been recognized—the Chagrin, Holly, and Papakating.

Chagrin series*.—The surface soils of this series are brown; the subsoils, light brown to yellowish-brown. To a depth of three feet or more the subsoil shows little change in texture or color.

These soils, which occupy level tracts adjacent to streams, are subject to overflow. They are utilized chiefly for hay and pasture. Where under cultivation, corn is the chief crop. The most important representative of the series is Chagrin silt loam.

The Holly series includes alluvial soils with gray surface and mottled gray, yellowish-brown and rust-brown subsoils. The topography is level and the drainage poor. Furthermore these soils are subject to annual overflow. Because of these unfavorable conditions the Holly soils are used chiefly for pasture. Holly silt loam and silty clay loam are important types.

The Papakating series has gray-black surface soils. The subsoils are mottled bluish-gray, gray, and yellowish-brown. As they are in the lowest parts of the flood plains of the streams of the region, they are naturally poorly drained, and subject to annual overflow. Tile drainage is necessary before these lands can be utilized for anything but pasture. Papakating silty clay loam is the chief type.

*These soils were included in the Huntington series in soil survey reports for several northeastern Ohio counties.

TABLE 1.—Soils of the Glacial Lake Region of Northeastern Ohio

	Lacustrine Soils							
Color of soil	Brown	Light yellowish-brown (Sands)	Grayish-brown (Sands)	Grayish-brown	Brownish-gray to gray	Dark gray (Sandy)	Very dark gray	Yellowish-gray
Color and	Yellowish-brown	Yellowish-brown	Yellowish-brown	Yellowish-brown	Mottled gray and yellowish-brown	Mottled Yellowish-brown and gray	Mottled bluish-gray and yellowish-brown	Mottled gray, yellowish-gray and brownish-yellow
Character of subsoil	Stratified sand and gravel at 20 to 40 inches Noncalcareous	Lower subsoil pale yellow Deep sand	Pale yellow below 24 inches Lower subsoil heavy below 50 to 60 inches	Lower subsoil heavy Noncalcareous to 50 or 60 inches	Lower subsoil heavy Noncalcareous to 50 or 60 inches	Lower subsoil heavy Noncalcareous to 50 or 60 inches	Heavy	Very heavy Bedrock (shale) at 36 to 80 inches
Topography	Beach Ridge	Undulating	Undulating	Undulating	Level	Level	Level	Level
Natural drainage	Good	Good	Good	Fair to good	Poor	Very poor	Very poor	Very poor
Series	**Chenango**, beach ridge phase	**Plainfield**	**Berrien**	**Painesville**	**Caneadea**	**Reynolds**	**Lorain**	**Wickliffe**
Important textures	Loam	Fine sand	Fine sand	Fine sandy loam Silt loam	Silty clay loam Silty clay	Fine sandy loam	Silty clay loam Silty clay	Silty clay

TABLE 2.—Soils of the Glacial Lake Region of Northeastern Ohio

	Deep Glacial Soils*					Shallow glacial soils (over sandstone and shale)	
Color of soil	Light brown	Grayish-brown	Brownish-gray	Light gray	Dark gray to grayish-black	Brown	Brownish-gray
Color and	Pale yellowish-brown	Pale yellowish-brown	Mottled gray and yellowish-brown	Mottled gray, yellowish-brown and rust-brown	Mottled bluish-gray, gray and rust-brown	Yellowish-brown	Mottled gray, yellowish-gray, and yellowish-brown

Character of subsoil	Mottled yellowish-brown and gray from 16 to 24 inches Heavier than surface soil Lower subsoil more friable	Mottled below 16 to 18 inches Lower subsoil brownish-drab heavy clay	Lower subsoil heavy silty clay			Bedrock (sandstone at 12 to 36 inches	Very heavy Bedrock (shale) at 12 to 36 inches
Topography	Gently rolling	Gently rolling	Undulating	Level to undulating	Level	Rolling to sloping	Undulating
Natural drainage	Fair	Fair	Very poor	Very poor	Very poor	Good	Very poor
Series	**Rittman**	**Ellsworth**	**Mahoning**	**Trumbull**	**Chippewa**	**Lordstown**	**Allis**
Important textures	Silt loam	Silt loam Silty clay loam	Silt loam Silty clay loam	Loam Silt loam Silty clay loam	Silty clay loam	Stony loam Silt loam	Silty clay loam
	Terrace soils (second bottom)				Flood plain soils (first bottom)		
Color of soil	Brown	Brownish-gray to gray	Brown	Gray	Brown	Gray	Gray-black
Color and	Yellowish-brown	Mottled gray to yellowish-brown	Yellowish-brown	Mottled gray, yellowish-brown and rust-brown	Yellowish-brown	Mottled gray, yellowish-brown, and rust-brown	Mottled bluish-gray, gray, and yellowish-brown
Character of subsoil	Stratified sand and gravel at 20 to 36 inches	Stratified sand and gravel at 24 to 36 inches	Lower subsoil heavy (silt and clay)	Lower subsoil heavy (silt and clay)			
Topography	Level	Level	Level	Level	Level	Level	Level
Natural drainage	Good	Poor	Fair to good	Very poor	Good	Very poor	Very poor
Series	**Chenango**	**Braceville**	**Mentor**	**Tyler**	**Chagrin**	**Holly**	**Papakating**
Important textures	Loam Silt loam	Loam Silt loam	Silt loam	Loam Silt loam	Loam Silt loam	Silt loam Silty clay loam	Silty clay loam

*For a complete discussion of these soils see Bimonthly Bulletin, July-August, 1926.

THE COST OF FARM REAL ESTATE MAINTENANCE

F. L. MORISON

Farm real estate maintenance charges run up to a surprisingly high figure when all the costs are taken into consideration. A tabulation of the records of 31 farm owners who were keeping detailed cost accounts of their business for the Department of Rural Economics during the 5 years 1920 to 1924, inclusive, shows that their total real estate maintenance charges, exclusive of interest on investment, amounted annually to almost $700 per farm, or $5.00 per acre. These farms had an average area of 139 acres, with the ordinary sort of buildings and fences found on a large proportion of Ohio farms of that size. Of this annual cost, repairs and depreciation on buildings constituted 41 percent; real estate taxes 33; upkeep of fences 11; drainage 9; miscellaneous, including water supply, gravelling lanes, grading, etc., 4; and insurance on buildings 2 percent.

TABLE 1.—Annual Farm Real Estate Maintenance Charges, Averages per Farm and per Acre, on Farms Keeping Cost Account Records in Greene and Medina Counties, Ohio, 1920-1924

Items of cost	Greene County 14 farms, av. 157 acres Annual cost		Medina County 17 farms, av. 126 acres Annual cost		Both counties 31 farms, av. 140 acres Annual cost	
	Per farm	Per acre	Per farm	Per acre	Per farm	Per acre
	Dols.	*Dols.*	*Dols.*	*Dols.*	*Dols.*	*Dols.*
Labor on buildings	96.79	0.62	86.54	0.69	90.99	0.65
Labor on fences	49.43	.31	26.59	.21	36.52	.26
Labor on drainage	35.65	.22	34.61	.27	35.07	.25
Labor miscellaneous	20.16	.13	19.57	.16	19.82	.14
Total labor*	202.03	1.28	167.31	1.33	182.40	1.30
Material for buildings	323.21	2.06	268.52	2.13	292.29	2.10
Material for fences	62.29	.40	23.05	.18	40.11	.29
Drain tile	39.24	.25	18.59	.15	27.56	.20
Miscellaneous material	8.68	.06	11.33	.09	10.18	.07
Real estate taxes	264.04	1.68	199.52	1.58	227.58	1.63
Insurance on buildings	9.68	.06	11.21	.09	10.55	.08
Total costs other than labor†	707.14	4.51	532.22	4.22	608.27	4.37
Gross cost	909.17	5.79	699.53	5.55	790.67	5.67
Increased value of buildings‡	131.37	.84	65.29	.52	94.02	.67
Net cost	777.80	4.95	634.24	5.03	696.65	5.00

*This labor includes, besides the labor of the farm operator at 30 cents per hour, the labor of hired help at cost of such labor and also the cash wages paid to carpenters, ditch diggers, and outside men employed to erect fences. Fully one-half of this total amount represents an actual cash expense.

†The items included in this sub-total are all cash-out-of-the-pocket expenses.

‡Depreciation on buildings was calculated in most cases at the rate of 2 or 3 percent of their inventory value, a conservative figure. Since a number of new buildings were constructed the increased value due to these new buildings was more than enough to offset depreciation. In Greene County, 2 new houses were built during this period, another house remodeled, 1 barn built, also 1 garage, 1 machine shed, 1 steel crib, and 2 poultry houses. In Medina County the following additions were made: 1 house, 1 barn, 2 silos, and 1 machine shed built; 2 houses and 2 barns remodeled.

A question may arise as to how much of this expense was cash. All of the items of cost, other than labor, appearing in the sub-total as $4.37 per acre, were paid in cash, as well as one-half of the total labor cost, which we have estimated, was paid out in wages to carpenters, ditch diggers, and other laborers. These make a total cash expenditure of $5.02 per acre. Deducting the increased value of new buildings, there is left $4.35 per acre as actual cash operating charges.

It may be of interest to calculate the rate of interest that would have been made on the investment had these farms been rented for cash. It is estimated that these farms would have brought an average cash rent of $7.50 per acre in 1924. If we assume that the tenants would have spent as much of their own time toward the upkeep of buildings and fences as these farm operators did, then the land owners would have received a net rent of $3.15 per acre, the difference between $7.50 and $4.35. The average value of these farms was $132 per acre in 1924. The net rent, then, would have been a return of 2.4 percent on the investment. In the past a part of the income from the ownership of land has come in the increased value of the land.

TREND OF FERTILIZER SALES IN OHIO

E. E. BARNES

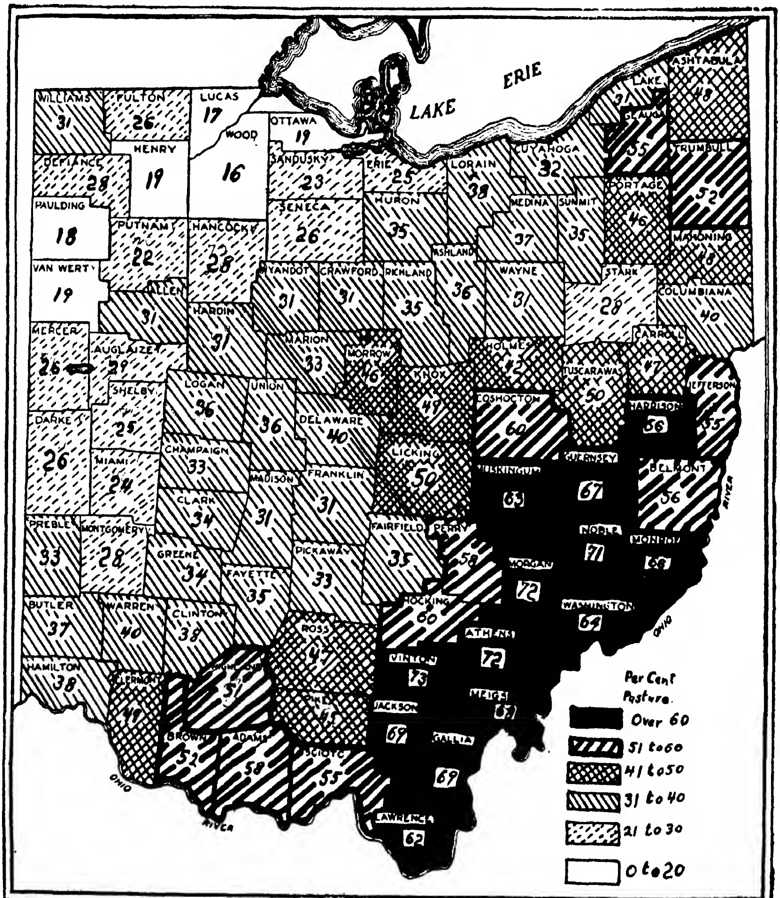
During the past five years the Soils Department of Ohio State University has compiled the figures relating to the sale of fertilizers in Ohio. These show the tonnage of each analysis sold each year. An interesting feature brought out in a study of these data is that altho the total tonnage in 1926 was less than in any other of the five years for which figures are available, except for 1923, yet the pounds of plant food sold in 1926 exceeded that of any previous year. This simply reflects the fact that higher analysis fertilizers are being used now than were used in previous years.

	Total tonnage	Tons of plant food elements	Average percent plant food contained
1922	310,885	50,298	16.1
1923	303,120	50,922	16.7
1924	321,287	54,689	17.0
1925	321,960	53,014	16.2
1926	304,480	54,785	18.0

LAND UTILIZATION

J. I. FALCONER

The 1925 census of Agriculture for the first time gives us some fairly adequate data relating to pasture acreages. For the State as a whole the census reports 11,694,956 acres of crop land and 8,137,800 acres in pasture. Forty-one percent of the total acreage was therefore in pasture. In the counties, the percentage ranged from 16 percent in Wood County to 73 percent in Vinton County. Of the total pasture acreage in the State 49 percent was reported as plowable, 23 percent as woodland pasture, and 28 percent as other pasture.



Land Utilization

Percent that pasture land was of total crop and pasture land in 1925

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

At the beginning of the year 1927 the price situation relative to Ohio farm products was somewhat spotted. Wheat, lambs, and wool were at a considerably lower price than at the beginning of last year. On the other hand hogs and milk, which are the two chief sources of farm income for the state, were bringing better prices than a year ago. As a whole Ohio farm prices stood at a level of 153 in December 1926 as compared to 158 for December 1925. For the United States in December 1926 the farm level was 127, 26 points below Ohio. Federal reports show that the 1926 crop yield in Ohio was 12 percent above the pre-war average.

The decline in all commodity prices which began about a year and one-half ago still continues. In December 1925 the all commodity price level was 159; at the close of 1926 it was 150. Wages on the other hand have maintained their high level. In November 1926 they were at a level of 230. The cost of living on the other hand as reported by the "National Industrial Conference Board" was 168. This would indicate that the real wage of the factory worker has increased 37 percent since pre-war days.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Ohio farm wages	Non-agricultural products U. S.	Prices Ohio farm lands	Farm products prices U. S.	Farm products prices Ohio
1913	102	....	104	105	....	100	104
1914	100	100	102	97	....	102	105
1915	103	101	103	101	100	100	106
1916	130	114	113	138	104	117	121
1917	181	129	140	182	111	176	182
1918	198	160	175	188	119	200	203
1919	210	185	204	199	126	209	218
1920	230	222	237	241	146	205	212
1921	150	203	164	167	122	116	132
1922	152	197	145	168	109	124	127
1923	156	214	166	171	108	135	134
1924	152	218	165	162	104	134	133
1925	161	223	165	165	97	146	159
1926	154	....	170	161		136	155
1926					....		
January	159	229	160	165	....	143	156
February	158	225	....	164	96	143	156
March	154	229	....	162	....	140	155
April	154	227	167	160	....	140	157
May	154	226	....	160	....	139	161
June	155	228	....	160	....	139	161
July	154	227	176	159	....	136	158
August	152	227	....	160	....	133	149
September	154	231	....	161	....	134	149
October	153	231	177	160	....	130	150
November	151	230	....	161	....	130	154
December	150	....	....	160	....	127	153

NEW MONOGRAPH BULLETINS

No. 395, Mineral and Vitamin Requirement of Pigs, with special reference to the effect of diet on bone development, by G. Bohstedt, R. M. Bethke, B. H. Edgington, and W. L. Robison. This is a technical bulletin, presenting a rather extended and detailed account of a series of eight experiments. Articles of a popular nature interpreting these data will appear shortly in the Bimonthly Bulletin.

No. 396, Variations in Costs of Producing Corn, Wheat, and Other Crops in Greene County, Ohio, by J. I. Falconer and J. F. Dowler. Cost-of-production data were collected from a group of representative farms, during the five years, 1920-1924. The data are tabulated and the several items in the cost of production under the different farm methods and on the different soils of the several farms are analyzed.

No. 397, Corn Stalks Vs. Field Plots as a Guide to the Fertility Requirements of the Corn Crop, by F. A. Welton, V. H. Morris, and R. W. Gerdel. This bulletin reports the more important results secured in a study of the value of "corn stalk tests" as a guide to the nitrogen and potash needs of the corn crop. The results from extensive tests were so variable and unreliable, that the authors advise farmers of the State against the use of this method as a guide in choosing fertilizers of the corn crop.

No. 398, Hogging Down Corn, by W. L. Robison, gives the results of experiments involving shotes of different weight in hogging down corn at different stages of maturity alone and with different supplements in various combinations.

No. 399, The Relation of Weather to the Date of Planting Potatoes in Northern Ohio, by John Bushnell. The best time to plant fits the growing period of the crop to the most favorable weather. With rural varieties, which are grown in northern Ohio, this is accomplished by planting at such a time that tubers develop during the cool weather of fall and maturity coincides with the end of the growing season.

No. 400, The Phosphorus Intake of Pre-school Children as Shown by a Dietary Study Made by the Individual Method, by Hughina McKay. This is a contribution to the knowledge of the food needs, and more particularly the phosphorus requirement, of children. The actual food eaten by each of 55 children was weighed for a period of four consecutive days, and the data are here classified and analyzed.

No. 401, Prevention and Control of Stomach Worms and Nodular Worms in Lambs, by D. S. Bell. The experiments here reported show the efficiency of various methods of management, alone or in combination with medicinal treatments, in preventing or controlling stomach-worm and nodular-worm infestation in lambs raised from infested, untreated ewes.

The Monograph Bulletins are sent free upon request by postal card or letter addressed to the Experiment Station, Wooster, Ohio.

The Bimonthly Bulletin

Vol. XII, No. 3 May-June, 1927 Whole No. 126

Ohio Agricultural Experiment Station

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OHIO AGRICULTURAL EXPERIMENT STATION

Wooster, Ohio, U. S. A.

WHAT THE TESTS IN PIG FEEDING TELL

Grain rations are deficient in minerals, vitamins, and proteins.

Grain rations fed in dry-lot resulted in unthrifty, lame, paralysed, and dead pigs.

Posterior paralysis in pigs was due to broken vertebrae, caused by rations poor in minerals and vitamins.

Ground limestone proved an efficient mineral supplement.

Cod-liver oil is rich in vitamins. It prevented or cured stiffness in pigs.

Tankage and fish meal contain efficient proteins and minerals, supplementing well those of grain mixtures.

Yellow corn contains a vitamin which is lacking in white corn, and is therefore superior to white corn in grain rations fed in dry-lot.

Alfalfa hay added to grain mixtures supplies necessary vitamins, also good minerals and proteins.

Pasture proved the one best practical corrective of a grain ration.

Direct sunlight was found to be beneficial to pigs.

A good winter ration may be made up of corn or other grain, balanced with the mixture of 2 parts tankage, 1 part linseed meal, and 1 part ground alfalfa hay, by weight. A suitable mineral mixture may improve even such an excellent ration, and is absolutely necessary with a grain ration.

BIMONTHLY BULLETIN

OF THE

Ohio Agricultural Experiment Station

VOL. XII, NO. 3 MAY-JUNE, 1927 WHOLE NO. 126

MINERALS AND VITAMINS IN RATIONS OF PIGS*

G. BOHSTEDT, R. M. BETHKE, B. H. EDGINGTON, AND W. L. ROBISON

Much is heard and read about the shortcomings of grain rations for pigs in dry-lot. Just what is a *grain ration*, and what is a *dry-lot*?

What is a "grain ration"?—The term "grain ration" or "grain mixture" is bandied about rather loosely. Many if not most farmers mean by the term any concentrate, or mixture of concentrates, whether composed of corn; corn and oats; corn, middlings, and oil-meal; or even corn and tankage. Strictly speaking, *grain* refers only to the whole or ground natural seed of corn or small grain that has not been changed in composition thru milling, degerminating, or other process, and therefore is not a so-called grain product, as wheat middlings. Nevertheless, a *grain ration*, or a grain mixture, has come to include not only *corn and small grains*, but in addition *a long list of grain or seed products*, as gluten feed, corn oil cake, wheat middlings, wheat bran, linseed meal, cottonseed meal, and soybean meal. Thus in general, a seed or seed product has come to be called grain in the literature of feeding. *Grain is a concentrate limited to plant origin.*

In experimental reports, therefore, the term "grain mixture" does not include mixtures that have ingredients of animal origin, as tankage, which is dried and ground meat and bone with some fat, or as fish meal, which is the dried and ground residue from fish-oil manufacture. The word "concentrate" incidentally may mean any one or a mixture of the feeds mentioned. Many feeders have come to apply the term concentrate to only high-protein feeds, as tankage, linseed meal, or cottonseed meal. As a matter of fact, car-

*This article summarizes a large part of Bulletin 395 of the Ohio Agricultural Experiment Station, entitled "Mineral and Vitamin Requirements of Pigs, With Special Reference to the Effect of Diet on Bone Development".

bohydrate feeds, as corn or barley, also are concentrates. *Any dry feed low in fiber or cellulose is a concentrate*, as opposed to roughages that are high in fiber and therefore bulky, like hay, stover, straw, oat hulls, or silage.

What is a "dry-lot"?—*Dry-lot* refers to *quarters*, for pigs or other farm animals, *that do not provide pasture* or forage crops. In many nutrition experiments animals are not even permitted access to soil, but are kept on a plank, brick, or concrete-paved floor. A dry-lot for pigs may be a pen in a barn, a pen in a barn with an outside runway, or a movable hog house with an adjoining enclosure that is bare of vegetation.

Are dry-lot and barnyard comparable?—There is thus no need for misunderstanding when speaking of a grain ration fed to pigs on experiment in dry-lot. Conditions on farms in the winter time only approximate such experimental conditions: pigs are ordinarily given more freedom even tho a grain ration is fed and the barnyards are frozen or snow-covered; pigs cannot always be prevented from eating a dead chicken or other animal; they may get a little kitchen refuse or perhaps a little skimmilk or buttermilk; or many times they run with cattle, which situation provides certain nutritional protection. Experimental results with pigs in dry-lot, on the other hand, represent somewhat extreme conditions, where the actual rations placed before the pigs are all they can hope to get. No apologies need be made for conducting such trials; in fact they are highly warranted, for facts of far-reaching practical importance have thus been brought to light.

Such results show the narrow nutritional margin of safety under which many pigs on farms exist. They explain why, during a long protracted or severe winter, pigs may fail to grow, may die from pneumonia, or contract "rheumatism", as many cases of stiffness or crampiness are called. Lameness and posterior paralysis also occur at times. A grain ration, unless properly supplemented, invites disaster. Feeding a grain ration, like corn, especially white corn, with wheat middlings, linseed meal, and salt, to pigs in the winter is much like feeding a growing boy only potatoes, beans, bread, and salt, without letting him have milk, eggs, meat, fruit, salad, including green leafy material, or vegetables. The boy cannot be expected to grow on the deficient diet, nor can a pig escape disaster sooner or later on the grain ration mentioned.

What is wrong with a grain ration fed in dry-lot?—Grains or seeds and their products are deficient primarily in minerals, and usually in vitamins and proteins. A serious shortcoming in any

one of these three is sufficient to cause stunted growth or worse consequences. Salt, or sodium chloride, is of course a leading deficiency, but this deficiency can easily be met.

Posterior paralysis was found to be due to fractured vertebrae, caused by rations low in minerals and vitamins.—Pigs that have become paralysed, in that they are unable to move their rear quarters, have puzzled veterinarians and animal husbandmen for

Fig. 1.—A simple mineral addition or pasture made the difference

Top picture—grain mixture alone. Three of the original 7 pigs died. The one at the left is severely paralysed.

Middle picture—ground limestone with grain mixture. Much improved growth, and strong bone. Vitamins are lacking, however, that are necessary for thrift.

Bottom picture—pasture with grain mixture. Abundance of vitamins, and fairly good minerals and proteins. The pigs are very thrifty. See Tables 1 and 6.

many years. One of the causes assigned to such instances was kidney worms. In these experiments at the Ohio Station it was found that such cases of posterior paralysis were associated with broken vertebrae in the lumbo-sacral region of the backbone. Such a broken vertebra in the backbone, which surrounds the spinal cord. would squeeze the cord, thus paralysing the rear quarters by

Fig. 2.—Why some hogs become lame

Longitudinal sections of normal and abnormal thigh bones of pigs showing on the left a normal bone produced on rations containing abundant minerals and vitamins.

The abnormal thigh bone on the right was taken from a pig fed a grain ration with 4 percent blood meal. The thickness of the bone is no indication of its strength. Nature has thickened the bone so as to help overcome its weakness, which is evident from the spontaneous fracture near its middle. A pig with such a thigh bone is, of course, a cripple, walking with difficulty.

stopping nerve impulses traveling between the brain and the rear quarters of the animal. Pigs that had become paralysed in this way were found only among those that had been fed the grain ration of corn, middlings, oilmeal, and salt without additional minerals. No kidney worms were found on autopsy of such posteriorly paralysed pigs. The ration alone was at fault.

Fig. 3.—A cause of posterior paralysis

Split section of backbone of pig, showing the fourth lumbar vertebra to be fractured. Such fractures account for the paralysed condition of the rear extremities. The pig from which this backbone was taken had been fed the grain ration of white corn, wheat middlings, linseed meal, and salt. Due to the mineral and vitamin deficiency of this ration the spinal vertebrae as well as thigh bones and other bones of the body were poorly ossified, and weak, and unable to withstand unusual strains, as thru crowding, or slipping on the floor. When a vertebra thus collapsed, it pressed on the spinal cord, acting as a nerve block, and thus causing sudden posterior paralysis. Kidney worms are often blamed when pigs are "down in the back". None of the considerable number of posteriorly paralysed pigs at the Ohio Experiment Station have, however, been found to have kidney worms.

Do minerals improve a grain ration?—During four experiments at the Ohio Station the mere addition of 2 pounds of ground limestone to 100 pounds of a mixture of white corn, middlings, oilmeal, and salt fed in dry-lot made the difference between a reasonable degree of success and failure, as follows:

TABLE 1.—The Effect of Adding Minerals to a Grain Ration Fed in Dry-lot.
Average of 4 experiments, using a total of 56 pigs*

Average length of experiment, 156 days	Average daily gain	Feed required for 100 lb. gain	Mortality	Strength of thigh bones†
	Lb.	*Lb.*	*No.*	*Lb.*
Grain mixture........................	0.66	548	9	447
Grain mixture and ground limestone	1.00	454	1	1041

*Two of the experiments were conducted in the hog barn, and two in outside dry-lots with pigs exposed to direct sunlight.
†Average of the two experiments in outside dry-lots.

The pigs in these experiments were kept in concrete or brick-paved pens. Nine of the grain-fed pigs died, in most cases from pneumonia as the immediate cause. It is known that a vitamin deficiency is a contributory factor to the onset of pneumonia. Several pigs became lame or crampy, and a few severely paralysed in their rear quarters. The addition of 2 pounds of limestone to every 100 pounds of the grain mixture enabled the pigs to gain 0.34 pound more daily, to save 94 pounds feed for every 100 pounds increase in live weight, and to escape severe stiffness or paralysis as well as lameness. The column to the extreme right in Table 1 indicates the greatly increased strength of bone where limestone was added to this grain ration. Near the end of the tests, which averaged 156 days in length, two pigs had a staggering gait, and one severe crampiness, proving that a mineral addition alone could not prevent the effects of a vitamin deficiency. The ration was low in vitamin A, which is present in relative abundance in yellow corn, butterfat, and alfalfa hay, and in great abundance in cod-liver oil. Vitamin D, in which cod-liver oil is rich and alfalfa hay relatively rich, was also lacking.

Minerals and vitamins greatly improved grain ration.—Table 2 shows the effect of making good both mineral and vitamin deficiencies by adding 2 percent limestone and from ½ to 1 percent cod-liver oil to a grain mixture of white corn, middlings, oilmeal and salt.

TABLE 2.—Both Minerals and Vitamins Added to a Grain Ration Fed in Dry-lot
Average of 4 experiments, using a total of 56 pigs

Average length of experiment, 161 days	Average daily gain	Feed required for 100 lb. gain	Mortality	Lameness, stiffness, or paralysis	Strength of thigh bones*
	Lb.	*Lb.*	*No.*	*No.*	*Lb.*
Grain mixture.....................	0.41	688	10	3	201
Grain mixture, ground limestone (or calcium carbonate), and cod-liver oil.........................	0.98	422	0	0	619

*Average of pigs in one experiment.

Table 2 shows that, in the limestone-cod-liver-oil lot, not only was the grain and feed expenditure for 100 pounds gain fairly satisfactory, but the pigs escaped stiffness, sometimes referred to as rheumatism, and death.

Tankage supplied good proteins and minerals.—That an animal protein feed, as tankage, may greatly improve a grain mixture of white corn, middlings, and oilmeal, is shown by the data of Table 3.

TABLE 3.—Tankage, an Animal Protein, Aids in Balancing a Grain Mixture Fed in Dry-lot (Both rations have same nutritive ratio)

Average of 1 experiment. Seven pigs per lot

Length of experiment, 154 days	Average daily gain	Feed required for 100 lb. gain	Mortality	Lameness, stiffness, or paralysis	Strength of thigh bones
	Lb.	*Lb.*	*No.*	*No.*	*Lb.*
Grain mixture..............	0.49	526	3	2	305
Grain mixture and tankage .	1.02	432	0	5*	569

*Slightly stiff, otherwise in apparently good condition.

Fig. 4.—"Beading" of the ribs—a sign of rickets, due to a vitamin and mineral deficiency in the ration

Vitamin and mineral-deficient rations frequently cause a contracted chest in pigs as well as other animals. Large knobs develop at the juncture of the bony with the cartilaginous parts of the ribs. Such pigs are apt to contract pneumonia. This one had been fed corn, middlings, oilmeal, blood meal, and salt in dry-lot.

Tankage in this case not only improved the protein of the mixture, but also added some much needed minerals, especially lime, thru the bone which it contained. Tankage did not greatly improve the vitamin content, hence several of the pigs became slightly stiff near the end of the trial. Fish meal had much the same effect as tankage.

White corn lacks vitamin of yellow corn.—White corn, which is low in vitamin A, was fed in these mixtures. Yellow corn would have introduced the missing vitamin, and would have given considerably better results, both in a grain ration, and with tankage, particularly if in addition the pigs had been exposed to direct sunlight. For it has been found that abundant direct sunlight (not sunlight that comes thru window glass) has the same effect as feeding vitamin D by means of cod-liver oil.

Fig. 5.—Vitamins of cod-liver oil are very effective

Top picture—grain mixture alone. Two pigs had already died and the others were not at all thrifty.

Bottom picture—cod-liver oil with grain mixture. One percent cod-liver oil added to 100 pounds of the white corn, middlings, oilmeal, and salt mixture caused wonderful growth and thrift.

Table 4 is given to show the difference in results between the feeding of yellow as compared with white corn in a grain mixture. It shows the record of two small groups of pigs, one on yellow and the other on white corn in the grain mixture, fed in outdoor, brick-paved pens. The equivalent of vitamin D was therefore supplied

TABLE 4.—Yellow Corn Compared with White Corn in a Grain Mixture, Containing Ground Limestone, Fed in Dry-lot*

Average of 1 experiment. Five pigs per lot

Length of experiment, 139 days	Average daily gain	Feed required for 100 pounds gain	State of thrift at end of trial
	Lb.	*Lb.*	
White corn in grain mixture	0.83	465	Fair
Yellow corn in grain mixture	1.12	418	Very good

*Not included in Ohio Bulletin 395.

by sunlight, but more or less imperfectly on account of much cloudy and rainy weather during the fall and early winter. Vitamin A was supplied the second lot by yellow corn. Ground limestone was added to both rations.

The rations were not ideal with respect to the proteins, minerals, and vitamins or vitamin equivalent, even for the yellow corn lot, nevertheless the pigs grew surprisingly well.

Fig. 6.—Yellow corn superior to white corn in a grain ration fed to pigs in dry-lot

Top picture—white corn in grain mixture containing ground limestone.
Bottom picture—yellow corn in grain mixture containing ground limestone.

Alfalfa hay a boon to hogmen.—White corn when fed under the above conditions is inferior to yellow corn, being worth only about 80 percent as much. Such trials, which almost invariably show yellow corn the winner, do not condemn white corn as unfit for winter feeding of pigs. Alfalfa hay, and to a lesser degree, other legume hays, may be added to winter rations containing white corn to make good the deficiency by introducing the vitamin of yellow corn. Leafy, pea-green alfalfa hay or meal also supplies good protein and mineral matter, all highly acceptable to a pig fed a grain ration in dry-lot. Table 5 presents the data from three experiments in which a ration of white corn, middlings, oilmeal, and salt was compared with the same mixture containing from 5 to 7 percent of ground alfalfa hay.

TABLE 5.—The Effect of Ground Alfalfa Hay in a Grain Ration of White Corn, Middlings, Oilmeal, and Salt, Fed in Dry-lot

Average of 3 experiments, using a total of 46 pigs

Average length of experiment, 161 days	Average daily gain	Feed required for 100 lb. gain	Mortality	Paralysed or severely stiff pigs
	Lb.	*Lb.*	*No.*	*No.*
Grain ration	0.51	601	11	5
Grain ration with ground alfalfa hay	0.91	418	0	0

Even leaving out of consideration the difference in gains and the casualty-and-cripple record, which ran into large numbers for the grain-fed pigs, and merely paying attention to the saving in feed required for 100 pounds gain, a ton of alfalfa hay was worth over $900. Alfalfa hay showed this seemingly ridiculously high value, because under the circumstances it functioned as preventive medicine. It very efficiently corrected the vitamin deficiency as well as other shortcomings of the grain mixture. Other tests have shown that the addition of 2 percent ground limestone with about 5 percent ground alfalfa hay to the grain ration results in an even more satisfactory mixture for growing and fattening pigs in dry-lot. About all that is needed in addition to prepare a near-ideal ration for pigs in winter is to add tankage or similar efficient animal-protein feed, and possibly to substitute yellow for white corn in the mixture. Therefore, the following protein-feed mixture of tankage 2 parts, linseed meal 1 part, ground alfalfa hay 1 part, by weight, to be fed along with corn, or a grain mixture, is highly efficient for pigs in the winter time.

Pasture a highly efficient corrective of grain ration.—So far dry-lot feeding only has been discussed. How effective might pasture be in fortifying a grain ration? Pasture furnishes wonderful protection to a pig fed otherwise a very one-sided and deficient ration. Pasture supplies the right kind of proteins, minerals, and vitamins that a grain ration lacks. Table 6 indicates the strong growth stimulus provided by pasture, even tho only bluegrass, one of the less valuable pastures.

TABLE 6.—The Effect of Pasture on the Growth and Health of Pigs Fed a Grain Ration of White Corn, Middlings, Oilmeal, and Salt

Average of 1 experiment. Seven pigs per lot

Length of experiment, 166 days	Average daily gain	Concentrates for 100 pounds gain	Mortality	Lameness, stiffness, or paralysis
	Lb.	*Lb.*	*No.*	*No.*
In dry-lot	0.65	450	3	2
On pasture	1.18	477	0	0

The pigs in dry-lot were confined to a brick-paved floor, but exposed to sunlight the same as the pigs out on pasture. The pasture pigs in addition to eating grass also rooted in the soil, which seems to have certain virtues as attested by a separate group of pigs that had access to a dirt paddock, bare of any vegetation. As long as the pigs in this bare lot could root in and chew the dirt, they

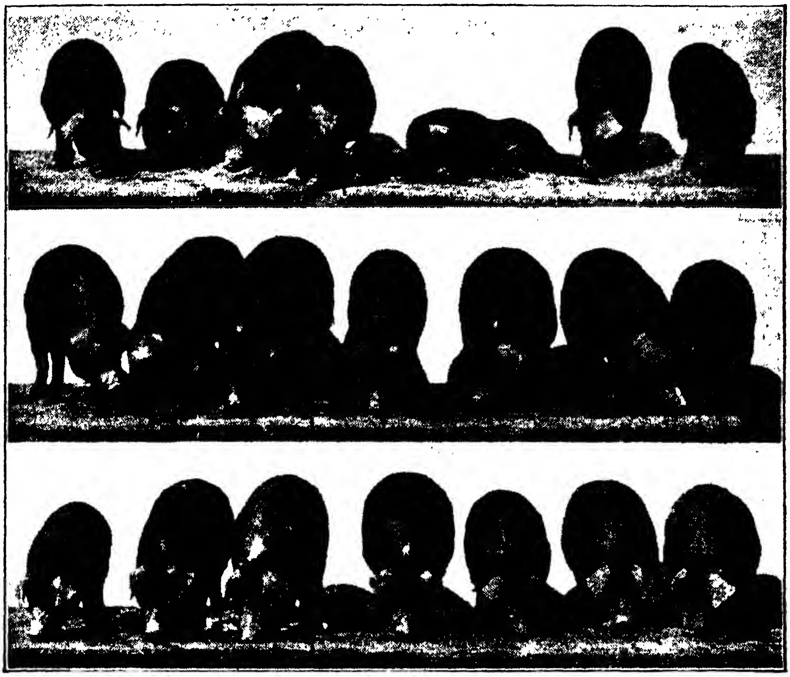


Fig. 7.—Tankage or alfalfa hay much improved a grain ration of white corn, middlings, oilmeal, and salt, fed to pigs in dry-lot, in barn

Top picture—grain mixture alone. Three pigs finally died. Four became stiff, two with fractured vertebrae and resultant posterior paralysis.

Middle picture—tankage with grain mixture. Very good proteins and minerals were introduced, resulting in better growth and stronger bones.

Bottom picture—alfalfa meal with grain mixture. This furnishes proof of the remarkable corrective properties of a good legume hay when only about 5 pounds of it are fed with every 100 pounds of a grain mixture. See Tables 3 and 5.

throve comparatively well, even tho they received only the standard grain ration in a self-feeder. As soon as freezing weather in late fall stopped their rooting, some of them became stiff and severely paralysed. The pigs on pasture, however, that in addition to chewing dirt consumed grass, had their systems well stocked with the

needed nutrients, especially vitamins, and never, from start to finish of the experiment, gave the least sign of malnutrition.

Direct sunlight beneficial to pigs.—Several references have been made to sunlight as a favorable factor in raising pigs. Mention was also made that sunlight coming thru ordinary window glass is not as effective as direct, unobstructed sunlight in the open

Fig. 8.—Dry-lot experiments with pigs at the Ohio Experiment Station

The pigs are sheltered in the movable houses along the sides of the outside brick-paved pens. Here the pigs are benefitted by the direct sunlight which they miss if kept inside of a barn.

Dry-lot feeding approximates winter conditions on many farms, and is therefore called for. Pasture, however, provides nearly all of the nutrients that are ordinarily lacking in a grain ration, and, therefore, is the best single, practical, corrective of such a ration.

air. Window glass filters out the light waves that have such a beneficial effect on growing animals. These light waves aid the animal system in depositing lime and phosphorus in the bones, hardening them, and thus avoiding deformities of the skeleton, as well as lameness and posterior paralysis. Direct sunlight of the kind that tans one's skin has the same property as vitamin D in cod-liver oil has in the calcification of bones.

In three experiments, the pigs, 27 in all, fed the deficient grain ration in *outdoor* brick-paved pens made on the average a daily gain

of 0.63 pound. Their thigh bones had an ash content of 56.8 percent and a breaking strength of 427 pounds. Where the same grain ration was fed to 19 pigs of two experiments conducted *indoors*, the pigs being comparable with the previous ones in weight at the start, altho of somewhat different origin, they made an average gain of only 0.30 pound per day. Their thigh bones analysed 55.0 percent

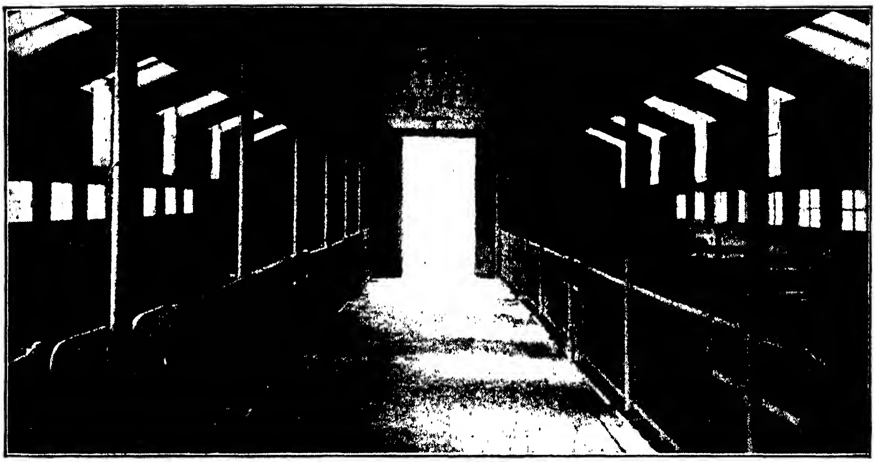


Fig. 9.—Inside of the Ohio Experiment Station Hog Barn where many of the pigs on these experiments were kept

The well-lighted interior provides pleasant quarters for the pigs, but the sunlight, coming as it does thru the skylights and windows on the sides, has lost its rickets-preventing power. Unless the ration is well fortified with minerals and vitamins, direct sunlight in the open air, or sunlight coming thru special glass substitutes, is needed to help enable pigs to thrive and grow dense and strong bone.

ash, and had a breaking strength of only 249 pounds. A similar relationship between outdoor and indoor pigs was found where calcium carbonate was added to the grain ration. Exposure to direct sunlight undoubtedly accounted for the somewhat better gains and the harder and stronger bones. Hogmen do well to let their pigs enjoy as much sunshine as possible during the season of the year when sunlight ordinarily is scarce enough at best.

Summary.—A grain ration for pigs in the winter, or for dry-lot feeding, was unsatisfactory because it lacked the proper amounts or the right kinds of minerals, vitamins, and proteins. Pigs were very apt to incur stunted growth, stiffness, posterior paralysis, and death.

Posterior paralysis was found to be due to broken vertebrae pressing upon the spinal cord, thus stopping nerve impulses travel-

ing between the brain and the rear quarters. Such paralysed pigs had invariably been fed a grain ration without additional vitamins or without additional minerals other than salt. There were no paralysed pigs on rations that were supplemented by ground limestone, bone meal, alfalfa hay, pasture, cod-liver oil, tankage, or fish meal, or combinations of some of these.

Ground limestone added to a grain mixture of white corn, wheat middlings, linseed meal, and salt, stimulated growth and prevented posterior paralysis. It did not prevent slight stiffness, and an occasional death. This was due to the fact that all the necessary vitamins had not been supplied.

Cod-liver oil together with ground limestone added to the grain ration of corn, middlings, oilmeal, and salt, produced rapid and safe growth, without casualties or even slight degrees of stiffness. Cod-liver oil furnished vitamins A and D, most frequently lacking in grain rations.

Tankage and fish meal added superior proteins to a grain ration in dry-lot, but little or none of the vitamins apt to be lacking. Since tankage and fish meal introduced very good minerals in the form of ground bone or bone meal, they enabled pigs to avoid severe stiffness or posterior paralysis, but not slight crampiness.

Alfalfa meal, or ground alfalfa hay, of the leafy, pea-green kind, added to a grain ration for pigs in dry-lot, supplied favorable proteins and minerals, but primarily vitamins A and D. Pigs fed ground alfalfa, especially when ground limestone was also added to the ration, throve much better and avoided posterior paralysis. The addition of tankage as well as limestone would still further ensure success with the resulting mixture of all three supplementary feeds—tankage, linseed meal, and alfalfa meal. Almost any grain or grain mixture with these added ingredients in the proper proportions will prove a highly efficient dry-lot ration.

Yellow corn proved superior to white corn in a winter ration. Numerous trials have shown that with ground alfalfa hay in the mixture, or when pigs are fed on pasture, little or no difference is found between the two kinds of corn.

Pasture proved the one best practical corrective of a grain ration. Pasture furnished abundant vitamins, easily assimilable minerals, and favorable proteins. It automatically provided soil in which to root, and, last but not least, allowed exposure to direct sunlight. Pigs bathed in sunlight in the open made better gains and grew denser and stronger bones than pigs fed the same rations but kept indoors.

JANUARY HATCHED PULLETS

D. C. KENNARD

The poultry industry has recently acquired two new enterprises—the all-year production of broilers and the production of pullets for sale. These enterprises were made possible as a result of the recent information on nutritional requirements and on what constitutes a complete ration for chickens. With these accomplishments it became possible in 1923 to raise chicks successfully indoors, a requirement for January hatched chicks. Since then the production of early broilers and pullets by means of hot water brooding plants has developed with surprising rapidity and promises to expand for some time to come. The initial development was stimulated by the high price of Easter broilers, but with increased production the early pullet promises to become the primary object and broilers a by-product as in the case of the later hatches.

The production of pullets for sale fulfills a real need and will no doubt come to be one of the important phases of the poultry industry. For after all it is the pullet not the day-old chick that is desired by most poultry keepers. Not long ago the individual poultry keeper did his own hatching. Now the hatchery is largely rendering this service. The next logical development is for the specialist with the modern brooding plant to carry the service one step further and provide properly brooded pullets for sale at a reasonable price.

The January hatched pullet like any new commodity on the market gives rise to numerous questions as to its merits or demerits. The January pullet is so new there has not been much opportunity for observing its behavior or determining the management for best returns. However, as the Station is receiving frequent inquiries on this subject it may not be untimely to attempt a general discussion of the subject on the basis of the meagre information now available. While this paper deals primarily with White Leghorns the advantages of January hatching of the heavier breeds should be greater because of the difficulty often experienced in getting them matured for production in October. It should be emphasized, however, that what is said at this time is based largely on observation and what is thot rather than on proven facts, hence liberal allowance should be made for exceptions in the discussion which follows.

Will the January hatched pullet molt in the fall?—This is usually the first question encountered. Like later hatched pullets they may or may not have a premature molt. In most cases it should be expected that they would go into a light molt lasting four to six weeks during the fall months. The early pullets that lay during July, August, and September are more likely to molt than later pullets. However, since there is no insurance that the later hatched pullets will not molt also, many poultrymen figure that it is better to secure three or four months' egg production from the early pullets than but one month's production from later pullets before they molt, as often happens. Granting that a majority of the early pullets will molt, it should not prove a serious matter. They usually give two or four months production before the molt and recover for heavy production during November or December. Like later hatched pullets their behavior in this respect will be largely governed by the feeding and management. In some cases the early pullets will be permitted to continue on the summer range before they are moved to winter quarters, say in September. Such a change at this time may be expected to throw them into more or less of a molt. If so, it would not prove very objectionable, for they should recover so as to lay well during November and December and, with the increased size of eggs, they may have greater returns to their credit January 1 than the later hatched birds.

Management of early pullets.—A summer range which provides sufficient green feed and shade is essential for economical development of the pullets. It is the best insurance for their development into profitable egg producers for the fall and winter months. It is important that the pullets be not crowded either on the range or in their roosting quarters and that every possible precaution be taken to avoid their becoming infested with intestinal parasites. The pullets should usually be moved to winter quarters not later than September 1 if winter production is the primary object. This change will often cause a light molt but they should soon recover. When favorable range conditions can be provided in connection with the laying house the pullets can be transferred to better advantage about August 1.

Feeding.—Generally speaking the pullets should not be forced for rapid maturity. The better plan is to feed so as to secure a steady, but rather slow, development so that only a few of the pullets will begin to lay before they are six months old. The Ohio all-mash mixture for chicks and growing pullets is well adapted for this purpose and yields about the rate of maturity desired. This mash

is composed of coarse-groun. yellow corn 70 pounds; winter wheat middlings, shorts, or coarse-ground wheat 20, medium (50-percent protein) meat scraps 5, granulated chick-size poultry bone meal 4, salt 1. No milk in any form is used after the pullets are 10 weeks old nor during the summer range period.

The laying ration is usually started when the pullets are placed in their winter quarters. If the pullets have a good range and it is desired to slightly retard their maturity the meat scraps may be reduced to 2 or 3 percent. However, if the early pullets are to maintain the summer and fall egg supply for a special market or for private customers, the laying ration may be started when they are four months old and milk in some form may also be used. In this way heavy egg production may be expected from July to October, inclusive, with a comparatively less production during November and December.

SOME ADVANTAGES OF JANUARY PULLETS

Egg production.—The January pullets will lay when egg prices are advancing because the hens quit laying before the later hatched pullets begin. This is important when a continuous supply of eggs is required for a special market or for private customers.

Owing to the uncertainties of winter egg production there is usually better assurance of a profit before January from the early pullets than from the later ones. Even if January hatched pullets do molt they should lay a profitable number of eggs either before or after molting. If the later hatched pullets molt in November or December, as often happens, their only chance for profitable egg production before January is lost.

The early pullets' eggs will be larger when the later pullets' eggs are still small and are being penalized in price for size. In some instances this is a considerable advantage in favor of the January pullets. Especially after a rather early molt they lay eggs of good size. This is of great advantage when it is desired to use the eggs for hatching.

Market price of birds.—The early pullets may be marketed after fall and winter production when prices are much higher than later when the general fall movement of hens to market takes place. This advantage will be realized even if the pullets are used for breeders and marketed in May.

Profitable sale of broilers has been an important factor and was responsible for the first production of January hatched pullets. However, as production of early broilers increases the price will likely decline.

Vigorous pullets can be expected from early hatches. It is a matter of common observation that the early hatched chicks are often more vigorous and hardy than the later hatched chicks from the same flocks.

DISADVANTAGES OF JANUARY PULLETS

Brooding more difficult.—The same brooding facilities that will serve for later hatched chicks may not prove adequate for January chicks in zero weather. Warmer brooder houses are necessary, larger heaters are required, and more floor space per bird should be provided for winter brooding. If winter brooding is to be conducted on a large scale a hot water heating system is quite necessary.

Early pullets more expensive.—In the first place higher priced eggs are used for hatching and sometimes, but not always, do not hatch as well as later. However, during the past two years, the only years for January hatching worthy of mention, no difficulty has been experienced with hatchability of the eggs collected during the latter part of December. On account of the price of eggs the January chicks cost more, and in addition the expense involved in their brooding and feeding is greater. This however has been compensated for during the past two years by the favorable returns from the broilers.

More subject to fall or winter molt.—The January pullet is too new for much to be known about its molting. But granting that a light molt of four to six weeks will take place, it should not prove a serious matter because of the production before and after the molt to be credited before January 1. Whereas, a molt in case of the pullet hatched after March usually means loss of profit from winter production.

Other disadvantages as well as advantages might be mentioned and will doubtlessly be forthcoming for future consideration.

COMPARATIVE VALUE OF SHEEP AND HORSE MANURE

J. S. CUTLER AND S. C. HARTMAN*

Frequently the question arises as to the relative value of sheep and horse manure. While a fairly good answer to this question can be secured from the comparative analyses of these two manures, their relative crop producing power can only be determined in actual field tests. Such a test was started in 1915 on the Washington County Experiment Farm. Twelve years' data are available which would seem to be sufficient to justify drawing fairly accurate conclusions.

The relative crop producing value of sheep and horse manure can be determined by comparing the increases secured on Plots 15 and 19, in sections E to H. The manure is applied on the corn and wheat crops in a 4-year rotation of corn, soybean hay, wheat, and mixed clover and timothy hay. Well-cared-for manure is used on both plots, being hauled directly from the barn to the field.

Manure is an unbalanced fertilizer, being relatively low in its content of phosphoric acid as compared to ammonia and potash. Both complete analyses of soils in the laboratory and the crop responses secured from applications of acid phosphate indicate that most Ohio soils are deficient in phosphorus. These reasons made it seem advisable to supplement the applications of both sheep and horse manure with acid phosphate in order to counteract the possible limiting effect of a lack of phosphoric acid. Two tons of sheep manure and 400 pounds of 16% acid phosphate were applied on both the corn and the wheat crops on Plot 15. Plot 19 received the same total quantity of acid phosphate, or 800 pounds in the rotation and 8 tons of horse manure distributed equally between the corn and the wheat. The increases in yield resulting from these treatments are given in the accompanying table.

The increases secured with 4 tons of sheep manure and 8 tons of horse manure are nearly identical for the soybean hay and wheat crops. A slightly larger increase in the corn yield was secured on the plot receiving sheep manure while the plot receiving horse manure gave a slightly higher increase in the yield of hay. However, the value of the increases secured with all crops from both horse and sheep manure are not widely different, indicating that

*Assistants in Agronomy, in charge of outlying experiments and superintendent of Washington County Experiment Farm, respectively.

the crop producing value of one ton of sheep manure is approximately equivalent to that of two tons of horse manure.

A study of the analyses of sheep manure made by Ames and his coworkers at the Ohio Experiment Station, indicate an average composition of fresh manure of 35 pounds of ammonia, 10 pounds of phosphoric acid, and 24 pounds of potash per ton of manure. Similar analyses of horse manure indicate an average composition of 17 pounds of ammonia, 5 pounds of phosphoric acid, and 15 pounds of potash to the ton. Thus, a ton of sheep manure contains approximately twice as much ammonia and phosphoric acid as horse manure, and one and one-half times as much potash. In other words, one ton of sheep manure is for all practical purposes equivalent to 2 tons of horse manure when the relative analyses of the two manures are compared.

Sheep vs. Horse Manure

Increases and Total Value per Acre

Plot	Treatment per rotation	Average increase per acre				*Value of increase
		Corn	Soybean hay	Wheat	Mixed hay	
		Bu.	*Lb.*	*Bu.*	*Lb.*	*Dol.*
15	Sheep manure 4 T. 0—16—0, 800 lbs.	16.49	605	13.20	1128	42.55
19	Horse manure 8 T. 0—16—0, 800 lbs.	14.64	627	13.09	1643	45.20

*Note: The following prices are used in computing the value of the increased corn and its stover $0.70 a bushel, wheat and its straw $1.25, soybean hay $20.00 a ton and mixed clover and timothy hay at $15.00 a ton.

These analyses, however, represent ideal conditions. Rarely are these quantities of fertilizing elements retained in the manure until it reaches the field. A large loss of all the important elements occur where manure is exposed to the weather. A material loss of nitrogen occurs whenever manure is handled which, however, is not entirely avoidable.

Thus, both the crop response and the chemical analyses point to the same practical conclusion that horse manure is only one-half as efficient a fertilizer as sheep manure. One ton of sheep manure may be expected to give practically equal results to two tons of horse manure.

BLOOMING SEASONS OF CHERRIES AND PLUMS

J. S. SHOEMAKER

The time of blooming of cherry and plum varieties is of interest in relation to cross-pollination, avoidance of late frost injury to the blossoms, order of spraying, and from other practical viewpoints.

In a number of varieties of cherries and plums cross-pollination is essential for fruit development. Altho many varieties bear fruit when self-pollinated, as a general rule, it is advisable to set out mixed plantings rather than solid blocks or isolated trees of one variety. Cross-pollination does not take place under orchard conditions unless varieties overlap in bloom.

Other things being equal, late blooming varieties are less likely to be injured by late spring frosts than early blooming ones.

For spraying it is desirable that varieties bloom at the same time. When early blooming varieties are interplanted with late blooming ones, it may be necessary to go over the orchard more than once with the same application to obtain effective results.

Varieties vary in season of bloom in different years and localities. However, they probably bloom in much the same relative order thruout the State.

This paper shows the relative time of blooming of varieties grown at Wooster, based on average season of bloom during the last five years (1922-1926).

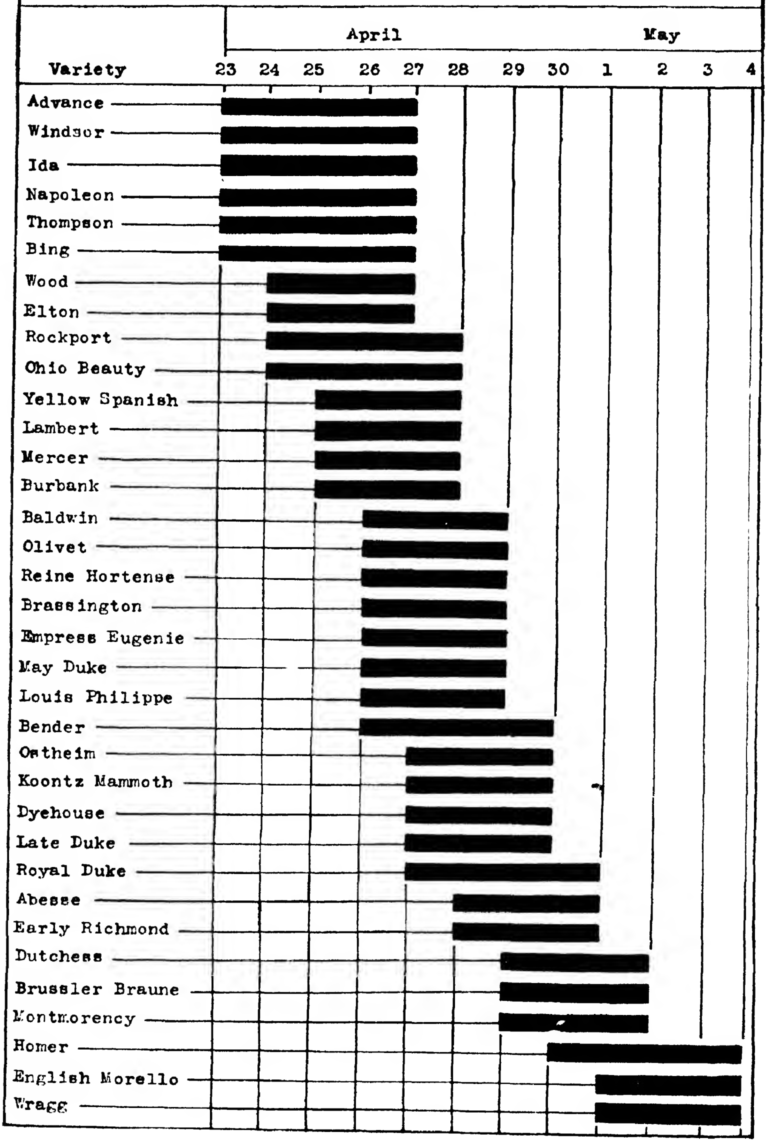
CHERRIES

Cherry trees usually take 2 to 4 days from first to full bloom at Wooster, and then 2 to 4 more days until the petals fall. The period of bloom effective for pollination is seldom more than 10 days for any variety, and usually it is less.

The average dates of first to full bloom of cherry varieties are illustrated in order of earliness in Figure 1. They are also grouped in order of average blooming season in Table 1. The sweet varieties bloom earliest, followed by the Duke or hybrid varieties, and the sour varieties.

In the average year, varieties with an early and those with a medium blooming season will probably overlap sufficiently for cross-pollination; likewise, those classified as medium and late, and those as late and very late. Varieties with a late or very late blooming season are not satisfactory pollinators for those with an early season.

FIG. 1—CHERRIES, FIRST TO FULL BLOOM, 5-YEAR AVERAGE



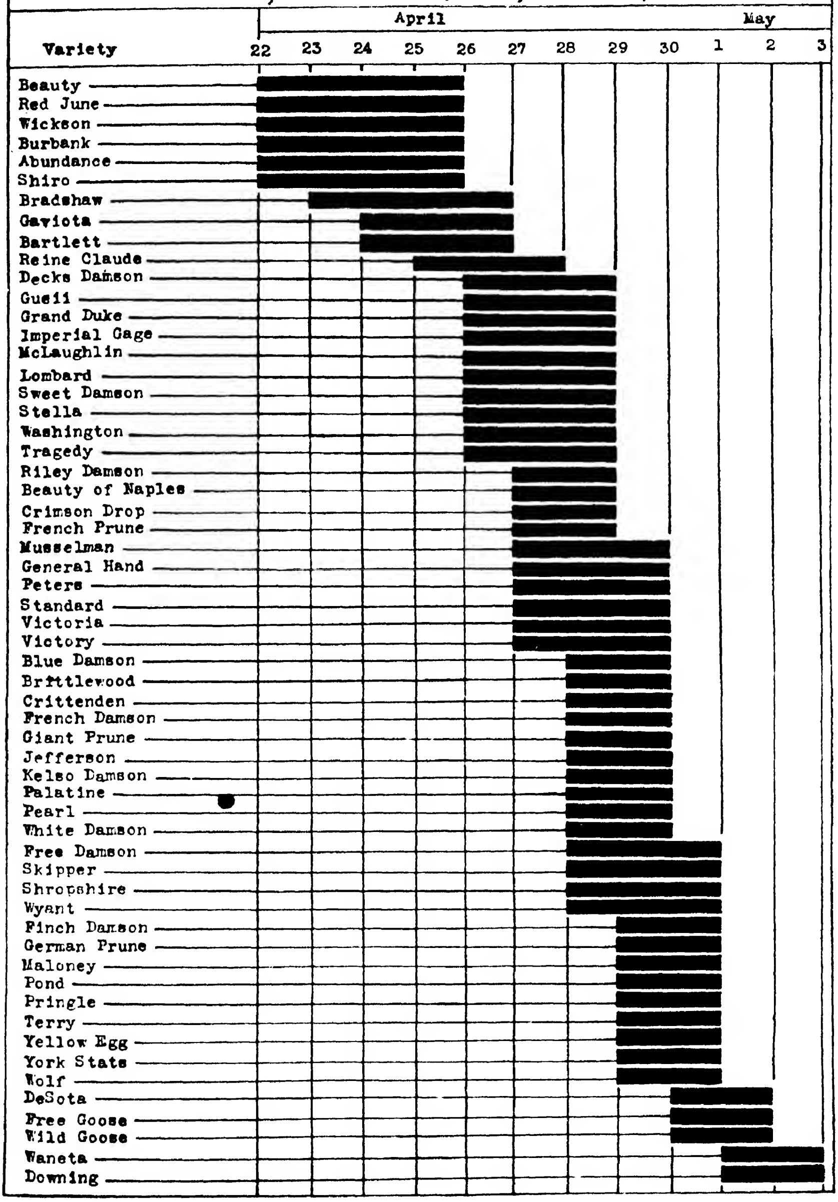


FIG. 2 - PLUMS, FIRST TO FULL BLOOM, 5-YEAR AVERAGE

The sweet cherries, which are all early blooming, require cross-pollination for fruit to develop. With many hybrids in the medium and late groups cross-pollination is essential, and in most varieties of this class it is necessary for full crops. There are some indications that standard sour varieties, like Early Richmond and Montmorency, will give larger crops when suitably cross-pollinated.

TABLE 1.—Cherries Grouped in Order of Average Blooming Season

Early	Medium	Late	Very late
Sweet	*Hybrid*	*Hybrid*	*Sour*
Advance	Baldwin	Abesse	Homer
Windsor	Olivet	Dutchess	Wragg
Ida	Reine Hortense		English Morello
Napoleon	Brassington	*Sour*	
Thompson	Empress Eugenie	Early Richmond	
Bing	May Duke	Montmorency	
Wood	Louis Phillippe	Brusseler Braune	
Elton	Bender		
Rockport	Late Duke		
Ohio Beauty	Royal Duke		
Yellow Spanish			
Lambert	*Sour*		
Mercer	Ostheim		
Burbank	Koontz Mammoth		
	Dyehouse		

The best pollinators for varieties in a given blooming season are varieties in the same group, with some exceptions. The chief exceptions are due to incompatibility. For example, Bing, Lambert, and Napoleon are cross-incompatible and therefore should not be depended upon to cross-pollinate one another.

Cool weather during and just previous to bloom lengthens the period of bloom, hinders the activity of honeybees and other pollinating agents, lowers the percentage of pollen germination, retards the rate of pollen-tube growth, and affects other factors of pollination and fruit setting.

In seasons with unfavorable weather, combinations of varieties that usually are timely as pollinators often are not effective In 1922, the blooming season came early and was long and cool. In that year many varieties that usually overlap in bloom did not do so. On the other hand, the blooming season of 1926 was later, shorter, and warmer, and many varieties overlapped in bloom that do not do so in average seasons. It is clear, therefore, that the average season of bloom is not an absolutely reliable index. However, it is probably the best general indicator available of the timeliness of cherry varieties as pollinators.

PLUMS

Plums, like cherries, usually take from 2 to 4 days from first to full bloom at Wooster, and about the same time from full bloom to last petal fall. The period of bloom effective for pollination is generally less than 10 days for any variety.

The average dates of first and full bloom of plum varieties for the five years are shown in order of earliness in Figure 2. The varieties are also grouped according to blooming season in Table 2.

The average season of bloom of Japanese varieties is earlier than that of European varieties. Certain hybrids (Wickson) and natives (Beauty) bloom early, and others (Waneta) (Downing) bloom very late. European varieties for the most part are medium season bloomers.

TABLE 2.—Plums Grouped in Order of Average Blooming Season

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Native	*Hybrid*	*Hybrid*	*Native*	*Native*	*Hybrid*
Beauty	Gaviota	Victory	Wyant	DeSota	Waneta
	Bartlett		Terry	Free Goose	
Japanese		*Native*	Wolf	Wild Goose	*Native*
Red June	*European*	Stella			Downing
Burbank	Bradshaw	Brittlewood	*European*		
Abundance			Shipper		
		European	German Prune		
Hybrid		Reine Claude	Maloney		
Wickson		Gueii	Pond		
Shiro		Grand Duke	Yellow Egg		
		Imperial Gage	York State		
		McLaughlin			
		Lombard	*Damson*		
		Washington	Free		
		Tragedy	Shropshire		
		Beauty of Naples	Finch		
		Crimson Drop	Pringle		
		French Prune			
		General Hand			
		Peters			
		Standard			
		Victoria			
		Giant Prune			
		Jefferson			
		Palative			
		Pearl			
		Damson			
		Deck			
		Sweet			
		Riley			
		Musselman			
		Blue			
		Crittenden			
		French			
		Kelso			
		White			

In the average year there is considerable overlapping of bloom of varieties in groups 1, 2, and 3; in 3, 4, and 5; and in 4, 5, and 6. Usually varieties in the following groups do not overlap sufficiently in bloom to be timely pollinators: 1 and 4, 5 or 6; 2 and 5 or 6; and 3 and 6.

None of the Japanese and hybrid varieties listed in Table 2 will give satisfactory crops when self-pollinated. A number of European varieties also are self-unfruitful. Most varieties which set some fruit when self-pollinated, as is the case with many commercial European plums, yield more abundantly when suitably cross-pollinated. As a general rule, greater yields are obtained by cross-pollination of varieties within a given species than between species.

The grouping as shown in Table 2 may be of assistance to the grower in selecting timely pollinators among plum varieties.

THE CABBAGE MAGGOT AND ITS CONTROL

HARRY L. GUI

Cabbage plants are subject to attack by several insects, none of which are of more importance than the cabbage maggot, *Hylemyia brassicae*, Bouche. This pest, like many others, was imported from Europe where it is also a pest of similar crops. Since its introduction, approximately a century ago, it has become widespread in this country, especially in the northern states and Canada. During this time much attention has been given to its control and in recent years efficient measures have been devised which when followed diligently prove successful.

THE INSECT AND ITS LIFE HISTORY

The cabbage maggot is the immature stage of a fly which somewhat resembles a house fly in form (Fig. 1, No. 4), but is smaller in size.

The winter is passed in the pupal stage in the soil, and the adults emerge in April or May, the exact time depending on the weather.

The eggs are tucked into crevices in the ground near the base of the plant and just below the surface, or sometimes attached to the stem of the plant near the ground. The eggs which are white in color (Fig. 1, No. 1) are large enough to be easily seen with the naked eye. They hatch after an incubation period of 4 to 12 days.

The maggots which hatch from the eggs are at first very small but increase in size until they become about ⅓ of an inch in length (Fig. 1, No. 2). The head is equipped with hook-like mouth parts

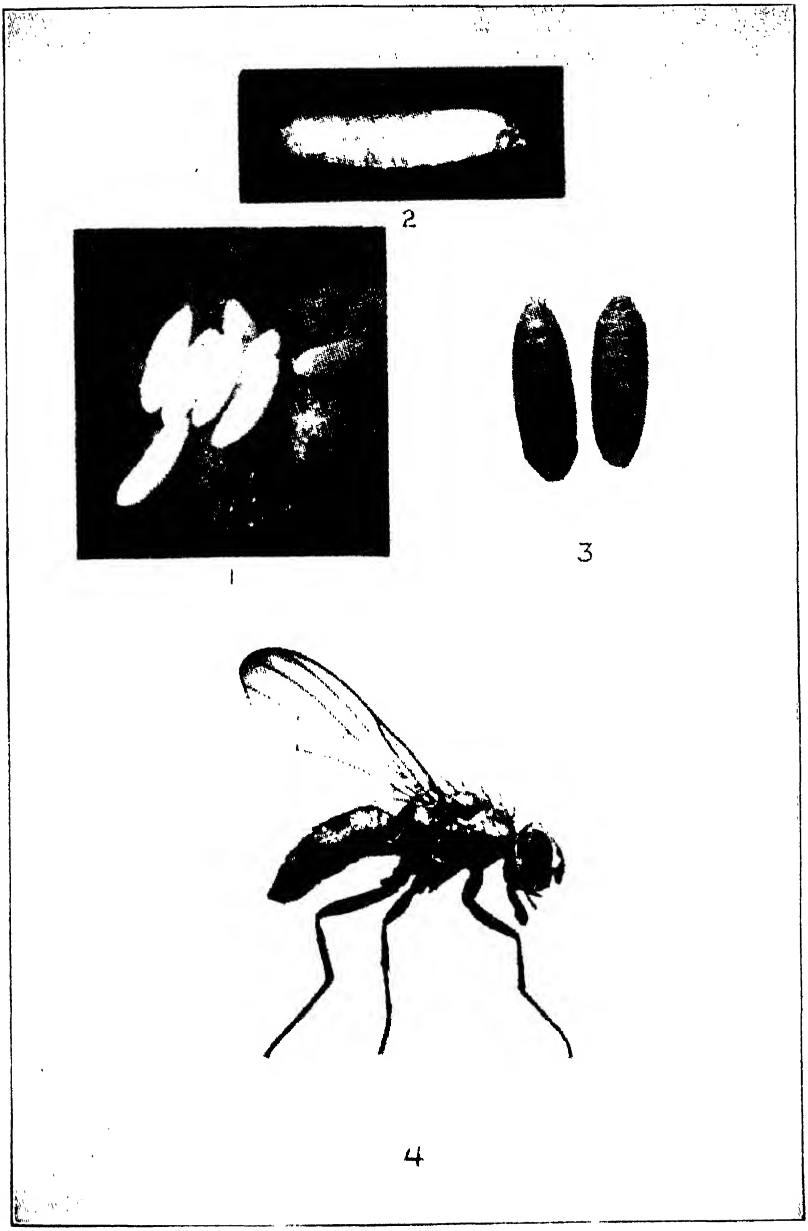


Fig. 1.—Life stages of cabbage maggot
1, eggs; 2, larva; 3, puparia; 4, adult female
(After H. Glasgow, New York Agricultural Experiment Station Bulletin 512)

with which the insects rasp the plant in order to obtain food. The color is creamy white. On hatching they work their way to the roots of the plants where they feed first upon the fine roots and later upon the tap root itself, where they usually may be found within their slimy burrows. Occasionally they bore upward in the stem of the plant as high as the midrib of the lower leaves. It is during this stage that injury results from their activities. The feeding period occupies two to three weeks. When the maggots become full grown and are ready to transform to the pupal stage, most of them migrate for a distance of one to several inches from the plant; altho some pupate within their burrows.

Fig. 2.—Early cabbage plants: Injured by the cabbage maggot (left), normal plant (right)

When transformation to the pupal stage takes place, the larva shortens and assumes a reddish-brown color and seed-like appearance (Fig. 1, No. 3). During the summer the pupal stage continues for 12 to 18 days. The life cycle is repeated three times during the season in Ohio, the pupae of the third brood hibernating over winter in the soil near the roots of the host plant or in the tissue of the plant itself.

HOST PLANTS

The cabbage maggot has a rather wide range of hosts, feeding and passing thru normal development on most of the Cruciferous plants. The cultivated crops attacked are cabbage, cauliflower, brussel sprouts, kohlrabi, radishes, turnips, rutabaga, kale, and rape. Weeds of the mustard family (Cruciferae), of which 23 species are listed from Ohio, all except shepherd's purse and winter cress, serve as host plants.

DESCRIPTION OF INJURY

Cabbage plants are subject to attack both in the seed bed and in the field, the latter being the case with early cabbage. Since the maggot attacks the roots the grower is frequently unaware of its presence until he observes the lighter color of the infested plants. The infested plants wilt down during dry weather and many of them eventually die (Fig. 2). Such plants are easily pulled up and when examined the roots will bear injuries inflicted by the maggot.

The fleshy radish roots are often riddled by the maggots, and become unfit for use (Fig. 3).

Fig. 3.—Radish injured by the cabbage maggot

NATURAL CONTROL

The several predators and parasites which attack the larvae and eggs are important factors in the control of the cabbage maggot, especially during the latter part of the season. It is thot that the activities of these are largely responsible for the small amount of injury done by the maggots of the second and third broods.

ARTIFICIAL CONTROL MEASURES

Cultural practices.—Sanitary cultural practices reduce the outbreaks of the cabbage maggot. Since the maggots of the fall brood feed in crop refuse it is important that all material such as cabbage stumps, radishes, and turnips be removed or destroyed. This will eliminate the source of food supply for the late brood which if allowed to develop would overwinter and become a source of infestation for the next season's crop. For the same reason it is desirable to destroy the weeds of the mustard family.

INSECTICIDAL CONTROL

Corrosive sublimate.—The use of corrosive sublimate, also known as mercuric chloride and mercury bichloride, is probably the most desirable from the standpoint of cost and convenience. It may be used either in the seed bed or in the field. This material acts as an ovicide, destroying all eggs with which it comes in contact, and it is also effective against very young maggots.

For cabbage plants use 1 ounce of corrosive sublimate in 10 gallons of water; and for the more tender plants, such as cauliflower, 1 ounce to $12\frac{1}{2}$ gallons of water. For small fields the solution may be prepared in the field. When this method is practiced the desired amount of corrosive sublimate should be measured out and stirred into a paste with a small quantity of water before being added to the bulk of the water. This will avoid difficulty in bringing the material into solution, since a film of air will form about the dry powder, preventing its going into solution.

Stock solutions are convenient and time saving. A water solution may be prepared by adding 4 ounces of corrosive sublimate to 1 gallon of water. A quart of this is equivalent to 1 ounce of the dry material.

A solution of higher concentration may be prepared by adding 5 ounces of the powder to 4 ounces of hydrochloric acid. A total of 5 ounces of the stock solution will result, 1 ounce of which is equivalent to 1 ounce of dry mercuric chloride. This acidulated solution should not be used on cauliflower and other tender plants since injury is likely to occur. The stock solution must be stored in glass, wooden, or earthenware vessels because of its rapid corrosive action.

DETAILS OF MAKING THE APPLICATION

In making the application, whether it be to plants set in the field or to plants in the seed bed either sown broadcast or in rows, enough of the solution should be used to wet the soil to a distance of an inch from the plant and to a depth of one inch. For field plantings $\frac{1}{4}$ pint per plant is adequate, and for seed beds, where the plants are in rows, 1 gallon to each 20 to 40 feet of row will suffice. When broadcast-sown beds are treated, 1 gallon is sufficient for 20 to 30 square feet of surface.

A sprinkling can may be used in making the treatment, using the rose sprinkler for broadcasted beds and removing it for drilled beds. If beds of considerable size are grown, a contrivance on wheels may be devised which will treat several rows at a time as it is drawn across the bed. Knapsack or other sprayers are convenient for use in the field and they may be fitted with extensions which will prevent the unnecessary labor of stooping for each plant treated. These receptacles should be cleaned before using, since some materials, like lime-sulfur, will cause the mercuric chloride to precipitate and settle out. It is then useless as an insecticide. A cloudiness of the solution is a sign of precipitation and if this occurs

the material should be discarded. Unless the vessels are thoroly cleaned after using slow corrosion will take place and damage them.

The time of treating the plants is important. The grower can best determine the proper time by observation. The soil at the base of the plants should be examined from time to time after the flies emerge to learn the beginning of the egg-laying period. This time has been found in New York to coincide rather closely to the date on which the Green Gage plums bloom. When the first eggs are found the first treatment should be made. After this, treatments are repeated at weekly intervals until eggs are no longer being deposited. This usually requires three and sometimes four applications. Under no circumstances should the treatment be made until all plants are well thru the ground, which is about five days after the first plants appear.

This method of control has several advantages. First is its efficiency; properly timed applications of a sufficient amount of mercuric chloride will prevent all maggot injury. Second is its safety; only occasionally does injury occur and then it is almost entirely confined to the primary leaves or to plants injured by flea beetles. Root injury has been known to occur in very sandy soil. Third is its effect on soil-borne diseases and soil insects— rhizoctonia, clubroot, and root rot are controlled by it and root injury by flea beetle larvae is prevented. Fourth is its stimulating effect and the production of stronger plants which may be due to the control of parasitic organisms. Fifth is its low cost, it has been found that one acre of seed bed can be given three applications of corrosive sublimate at a cost of about $75, or approximately 7 cents per 1000 plants. Its principal disadvantage is that it does not control the maggot after the plant has become infested.

The corrosive sublimate treatment will probably do as much for radishes as for cabbage but it cannot be given an unqualified recommendation until more investigation has been made to determine the proper dosage and the effect on the crop.

Tobacco dust not recommended.—Tobacco dust has also been used in the control of the cabbage maggot with a fair degree of success. Three to five applications must be made at the rate of 1 pound to each 30 to 40 feet of row. Tobacco dust does not act as an insecticide but rather as a repellent and, therefore, must be kept on the bed from the first appearance of the flies until egg-laying or oviposition has been completed. Tobacco dust is a good fertilizer and causes plants to grow vigorously. It has been pointed out that corrosive sublimate keeps certain soil-borne diseases in check.

Tobacco dust works conversely, favoring the development of these diseases. The cost factor is also important. The New York Experiment Station has shown the cost of treatment with tobacco dust to be $254 per acre, or about 24 cents per thousand plants, as compared with $75 per acre for corrosive sublimate. Since tobacco dust is no more efficient, is favorable for diseases, and costs much more than the mercuric-chloride treatment there seems to be no ground for its use.

MECHANICAL PROTECTION

Screening cabbage seed beds.—The use of cloth screens to protect the seed beds is quite common in certain parts of the country. These screens may be made of cheesecloth, having 24 to 26 threads per inch. A coarser mesh will allow insects, especially the flea beetles, to enter and cause injury to the plants. A finer mesh will cause the development of spindly plants due to shading. The cheesecloth may be stretched over a frame of boards, or it may be placed over the bed in such a way that the plants can raise it as they grow. In the latter case it will be necessary to allow the cloth to lie loosely over the beds so it may be easily raised by the plants at the borders; otherwise they will develop into crooked and small plants. The cloth must be fastened to the ground at frequent intervals to prevent blowing off and also to keep the adult flies from entering. The screen should be so arranged that it can be removed for weeding or cultivation, which should be done only on cool and dark days when the flies are inactive. The beds should not be left uncovered any longer than is necessary while the eggs are being laid and all holes in the cloth should be mended at once.

The screen method of control is as effective as any but no more so than a thoro and timely treatment with corrosive sublimate. The cost of this method is rather great. The cost of the screen without walls and assuming that the cloth will last three years has been found to be somewhat over $100 an acre per year, or 10 cents per 1000 plants. When side walls are used, assuming the lumber to last five years the cost of this protection is doubled.

It has been found, however, that the plants develop more rapidly under cloth than in the open bed and are ready to be transplanted several days sooner.

One of the chief objections to the use of cloth is that of disease control, since the various seed-bed diseases find the conditions under cloth very favorable for their development.

Screening radishes.—Radishes, which are also a preferred host of the cabbage maggot, have been successfully grown under cheesecloth stretched on a frame. This method is particularly applicable to the kitchen garden. After the second set of leaves appear on the young radish plants they may be thoroly weeded and eight-inch boards set six inches apart on each side of the row. Short boards are nailed across the ends to hold the sides in an upright position and cheesecloth tacked across the top of the frame. This method prevents infestation by the maggot by excluding the parent flies. It also prevents attack by flea beetles. The radishes so grown not only produce larger yields but their quality is improved.

Tar paper disks for cabbage and cauliflower.—The early crop of cabbages and cauliflower may be protected by the use of tar paper disks cut from single-ply tar building paper. These are placed around the plant near the surface of the ground. The disks are about three inches in diameter, with a hole in the center to fit the stem of the plant, and a slit from the center to the outer margin of the disk in order that it may be placed in position. They are easily made at home or they may be purchased from insecticide supply houses, and are easily applied, since it is only necessary to slip the disk around the stem of the plant. The disk should fit snugly and lie flat on the surface of the soil. This is an old and effective method but for some reason has not come into general use.

For the control on the field crops one must rely upon cultural practices and sanitation since the cost of placing protectors on such crops is prohibitive.

SOURCES OF MINERAL IN THE DIET OF PRE-SCHOOL CHILDREN

HUGHINA McKAY

To what extent do human feeding practices follow the road indicated by the results of carefully controlled feeding experiments? H. C. Sherman, of Columbia University, an authority on foods and food products, has stated that American dietaries are probably more often deficient in calcium than in any other chemical element and that the "value of milk as a source of calcium is a large factor in its unique importance in the diet." He and Hawley have also shown experimentally with children that the calcium of milk is utilized to

better advantage than is the calcium of vegetables. As a result of this experimental work they recommend a gram of calcium daily in diets for children, this calcium to be furnished by milk.

Recently the diets of 55 healthy normal Ohio children, 25 in private homes and 30 in an institution, were studied and the mineral and other constituents of the diet during a 4-day period determined. In addition the principal sources of calcium, phosphorus, and iron in these diets were ascertained.

It was found that more than half of the 25 children from private homes were having a gram or more of calcium daily. Only 2 children were having an amount much below this. Of the 30 institution children included in the study no child reached the standard of one gram daily, altho a good many closely approached it. On the other hand, few deviated very much from the average. There was not as great a variation in amounts of calcium taken by the institution children as by the private-home children. In other words, the institution diets seemed in this respect as in others to be neither excellent nor very poor, while the private-home diets were more likely to be either excellent or the reverse.

Milk, in varying amounts, was used by all the children and by far the largest part of the calcium in the diets came from its use. With one exception every child was receiving 70 percent or more of his calcium from this excellent source.

Milk led in all the diets as a source of phosphorus also. Ninety-five percent of the entire group of 55 children were getting 50 percent or more of their total phosphorus from milk. In the main children who were getting generous amounts of calcium were also getting generous amounts of phosphorus. This would naturally follow when milk is used liberally.

Altho milk is considered a poor source of iron it is surprising to what an extent the iron of milk contributed to the total iron these children had. For 76 percent of the children, one-fifth or more of the iron was derived from milk. The institution children, with their more limited use of fruits and vegetables, were more dependent upon the iron from milk than were the private-home children. Consequently the amount of iron in the diets of the former group was lower than that of the latter.

Eggs, fruits and vegetables, and the whole cereals are the foods depended upon in the main as sources of iron in children's diets. The generous use of these foods by the private-home children assured, in some cases a liberal and in other cases a fair supply of iron in their diets. The institution children, however, with their

very limited use of eggs and only moderate use of fruits and vegetables were getting less than the amount of iron recommended by Dr. Sherman.

The use of whole cereals as sources of iron is of special interest in diets of restricted cost. The statement has been made that the cost of providing an adequate diet is considerably less when the whole rather than the highly milled cereals are used. The person having a liberal income can afford to pay for spinach, eggs, meat, fruit, and vegetables. For the person on a restricted income some cheaper source of iron is advisable and the whole cereals constitute such a source.

Calculation of the amounts of minerals that the diets of the institution children would have contained if entire cereals had been used instead of the highly milled ones brings out the fact that the iron as well as the phosphorus content of the diets would have been raised by such a change. It would seem that when cost is a factor of importance, the generous use of the whole cereals is to be recommended with reference to improving the mineral, especially the iron and phosphorus, content of the diet.

STATION FIELD DAYS

Livestock Day at Wooster, Friday, May 27;
at Fostoria, Tuesday, May 31;
at Bellefontaine, Thursday, June 2;
at Circleville, Saturday, June 4.

Poultry Day school at Wooster, Thursday, June 16;
day at Wooster, Friday, June 17.

Wheatfield Week at Wooster, Tuesday-Friday,
June 21-24.

Orchard Day at Wooster, Friday, August 19.

PEOPLE ON OHIO FARMS

J. I. FALCONER

An outstanding development in Ohio has been the continued and rapid growth of cities. To the Ohio farmer this has meant the growth of local markets. Since 1910, however, the number of people on Ohio farms has not been increasing. While our agricultural output has continued to increase this increase has been brought about by greater efficiency in production of the individual farmer rather than by increase in numbers.

The Federal census for 1920 and 1925 shows that in 1920, 19.8 percent of Ohio's population lived on farms, while in 1925 it was 16 percent.

Ohio Population

	Farm population	Total population	Percent on farms
1920	1,139,329	5,759,394	19.8
1925	1,031,718	6,471,000	15.9

The census also shows that the number of people employed in agriculture in the State increased slightly from 1900 to 1910 and decreased from 1910 to 1920. Similar figures for 1925 are not available. The data show that in 1920 of those gainfully employed in Ohio about 19 percent were in agriculture.

Ohio Occupation Statistics

	Agriculture		All Occupations	
	Male	Female	Male	Female
1900	399,909	14,753	1,299,944	246,071
1910	406,542	12,881	1,572,343	346,712
1920	349,997	10,658	1,891,546	409,970

The 1920 census also gives some interesting data relating to farm help, unfortunately similar data are not available for a later date.

Number of Farm Laborers in Ohio

	1910	1920
On home farm	55,916	28,524
Working out	94,502	70,642
Total	150,418	99,166

COMPARATIVE PRICES OF OHIO FARM PRODUCTS

J. I. FALCONER

As a whole the prices of Ohio farm products during 1926 just about maintained the level which they reached in 1925. Prices started in January, 1926 at a level of 156, in June they reached 159 which was the highest point of the year. In December they were 151. Since that time they have declined to a level of 144 in March 1927. The accompanying table, however, which is based upon Ohio farm prices, shows that there is still a wide variation in the comparative price level of our different farm products. The price situation of an individual producer therefore depends somewhat upon the nature of the products which he has to sell. Of our staple crops potatoes ranked highest in price in March 1927; while hay, corn, and oats, our leading feed crops, were low. Fortunately for the Ohio farmer not many of these latter products are sold. Of our livestock and livestock products, lambs and wool have shown lower price levels, but are still bringing good prices. Dairy products have maintained their comparatively favorable prices. Hog prices, which have maintained a ratio to corn prices of over 18 to 1 since November 1925, are thus still in the longest period of sustained favorable price ratio for the past twenty years. Egg prices, which were high during the year 1926, fell to low levels in January 1927. As for years past horses have maintained a low price level altho they are now showing improvement.

Index Numbers of Ohio Farm Products
1909-1914=100

	1921	1922	1923	1924	1925	1926	March 1926	March 1927
Corn	93	99	132	152	171	108	109	106
Wheat	138	117	114	122	171	150	168	128
Oats	94	97	119	119	115	98	103	106
Potatoes	174	177	143	134	175	226	336	204
Hay	94	85	88	112	88	106	111	98
Eggs	153	136	140	145	162	152	113	98
Chickens	187	172	170	180	188	201	214	199
Hogs	113	121	100	108	157	169	169	154
Beef cattle	110	107	114	115	126	123	122	119
Lambs	143	176	186	194	220	214	194	197
Sheep	99	134	144	150	168	161	160	152
Wool	111	178	227	208	217	176	210	176
Veal	123	120	127	128	138	150	148	149
Milch cows	120	112	114	114	121	134	130	140
Horses	72	66	62	58	58	62	64	69
Butter	155	143	168	167	170	174	172	189
Milk	168	142	178	159	173	165	155	163
Average	132	127	134	133	159	155	155	144

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

During January and February the general level of prices for Ohio farm products showed some decline over that for the closing months of 1926. Lower egg prices were the most important item in this decline. The all commodity price level and the prices of non-agricultural products as reported by the Federal Bureau of Labor have also declined but not as much as has the price level of Ohio farm products. The intentions-to-plant survey of the Federal Department shows that the farmers of the United States intend to plant a potato acreage for 1927 of 15 percent more than the 1926 acreage; the farmers of Ohio 12 percent more.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Ohio farm wages	Non-agricultural products	Farm prices U. S.	Farm prices Ohio
1913	102	....	104	105	100	104
1914	100	100	102	97	102	105
1915	103	101	103	101	100	106
1916	130	114	113	138	117	121
1917	181	129	140	182	176	182
1918	198	160	175	188	200	203
1919	210	185	204	199	209	218
1920	230	222	237	241	205	212
1921	150	203	164	167	116	132
1922	152	197	145	168	124	127
1923	156	214	166	171	135	134
1924	152	218	165	162	134	133
1925	161	228	165	165	146	159
1925						
January	163	223	156	165	146	155
February	164	220	.....	177	146	155
March	164	224	.....	165	151	159
April	159	218	163	162	147	158
May	158	221	.....	161	146	161
June	160	220	.....	163	148	165
July	163	220	168	164	149	166
August	163	222	.....	164	152	163
September	163	223	.....	163	144	157
October	160	225	173	164	143	151
November	160	226	.....	166	144	157
December	159	229	.....	165	143	158
1926						
January	159	229	160	195	143	156
February	158	225	.....	164	143	156
May	154	226	.....	160	139	161
June	155	228	.....	160	139	161
July	153	227	182	159	136	158
August	152	227	.....	160	133	151
September	153	231	.....	161	134	149
October	153	231	177	160	130	149
November	151	230	.....	161	130	153
December	150	232	.....	158	127	151
1927						
January	150	232	178	156	126	145
February	149	.....	.....	155	126	144

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Ohio Agricultural Experiment Station

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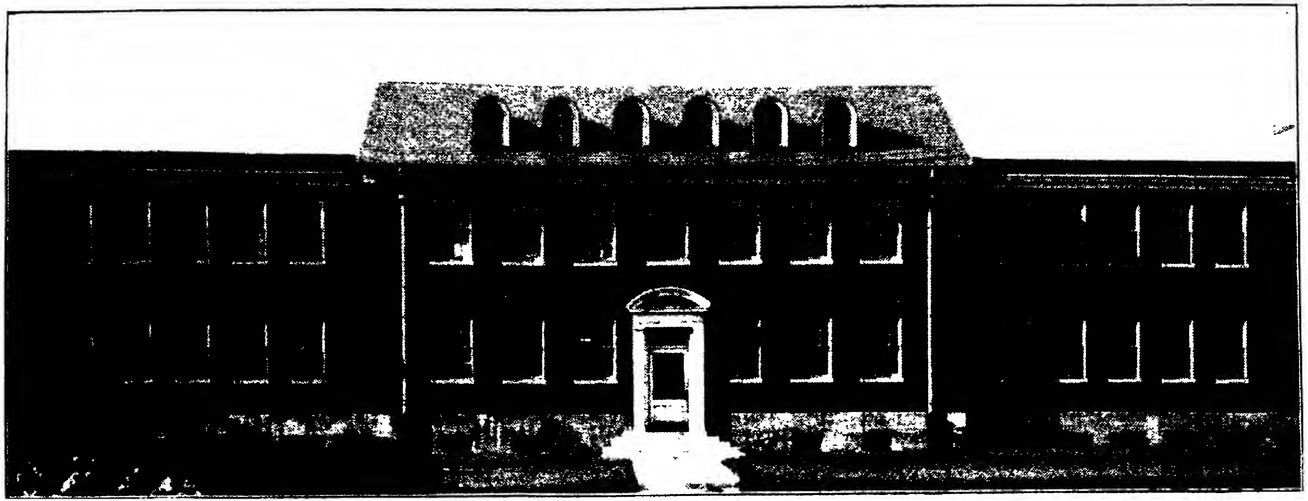

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SWEET CLOVER

The Effect of Cutting the First Year on the Value for Pasture and Soil Improvement the Next Year

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The only time that sweet clover produces a really satisfactory hay is in the fall of its first year's growth. Since many farmers in parts of this State and elsewhere make large use of this "stubble" sweet clover hay, the effect of its removal on the development of the plant and on its soil-improving and pasture value is a question of practical importance.

Previous observations on the effect of cutting the fall hay crop.—Most writers on sweet clover have agreed that sweet clover is not injured by cutting the fall hay crop, provided the crown buds are well developed before the hay is cut.

Coe (1)† notes that fall clipping "has had a marked effect on the growth of plants the following spring on some fields and no apparent effect . . . on other fields". He is unable to account for the difference. Fraser (2) definitely recognizes the effect of clipping or heavy early pasturing on development the next year, and recommends that sweet clover not be pastured in the fall until it is 12 to 15 inches high. He also makes clear that the effect is due to the poor root development secured when the tops are removed, and mentions heaving of the small roots on heavily pastured fields. The Tennessee Agricultural Experiment Station (3) reports winter killing and poor spring growth of sweet clover cut for hay the fall before.

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†Reference is by number to "Literature Cited", page 114.

Experiments at the Ohio State University.—Four years' observations and experiments at the Ohio State University have shown that cutting first-year sweet clover hay in the fall reduces the amount of material stored in the roots and thus lessens the soil improving and pasture value of the crop the next season. The writer has shown (7) that first-year sweet clover tops ordinarily reach their maximum weight and stop vegetative growth on the Ohio State University farm at Columbus, September 25 to October 1, but that the roots usually double in weight between that time and freezing weather if the tops are undisturbed. Not only do the roots gain in dry weight during October, but they increase in nitrogen content.

This rapid growth of the roots is not due to the transfer of material from the tops to the roots, except perhaps to a very slight extent. It is material produced by the leaves during the last month of growth. The tops on November 1 weigh nearly as much and contain nearly as much nitrogen as on September 25. In 1926, for example, first-year sweet clover cut 2450 pounds of hay containing 18.66 percent of protein on September 9, 3060 pounds of hay containing 18.66 percent protein on September 25, and 2760 pounds of hay containing 15.32 percent protein on November 3.

The leaves are the food factories of the plant. The sweet clover crop completes its leaf growth about October 1, and then works vigorously for a month storing material in the roots, much as sugar beets and other root crops do. Sweet clover may well be considered a root crop, since yields of roots amounting to six tons per acre green weight have been secured in these investigations, and other investigators have reported even larger yields.

Cutting hay prevents storage in the roots.—However, if the sweet clover is cut, the factory is destroyed and production ceases. New sweet clover shoots practically never start from the crown except in the spring of the second year. When the crop is cut any time in the first year, the plants either send out new shoots from buds along the stem, die, or, as usually happens when they are cut after September 1, remain dormant until spring. Occasionally some of the crown buds start in the fall, but the growth they make is unimportant and results in little storage in the roots.

This means that after sweet clover hay is cut, the roots become no larger or heavier than they were at the time the hay was cut (Fig. 1). This is, of course, exactly what we should expect. No sugar beet or potato grower would expect to mow the tops from his crop a month before maturity and harvest a full yield of beets or

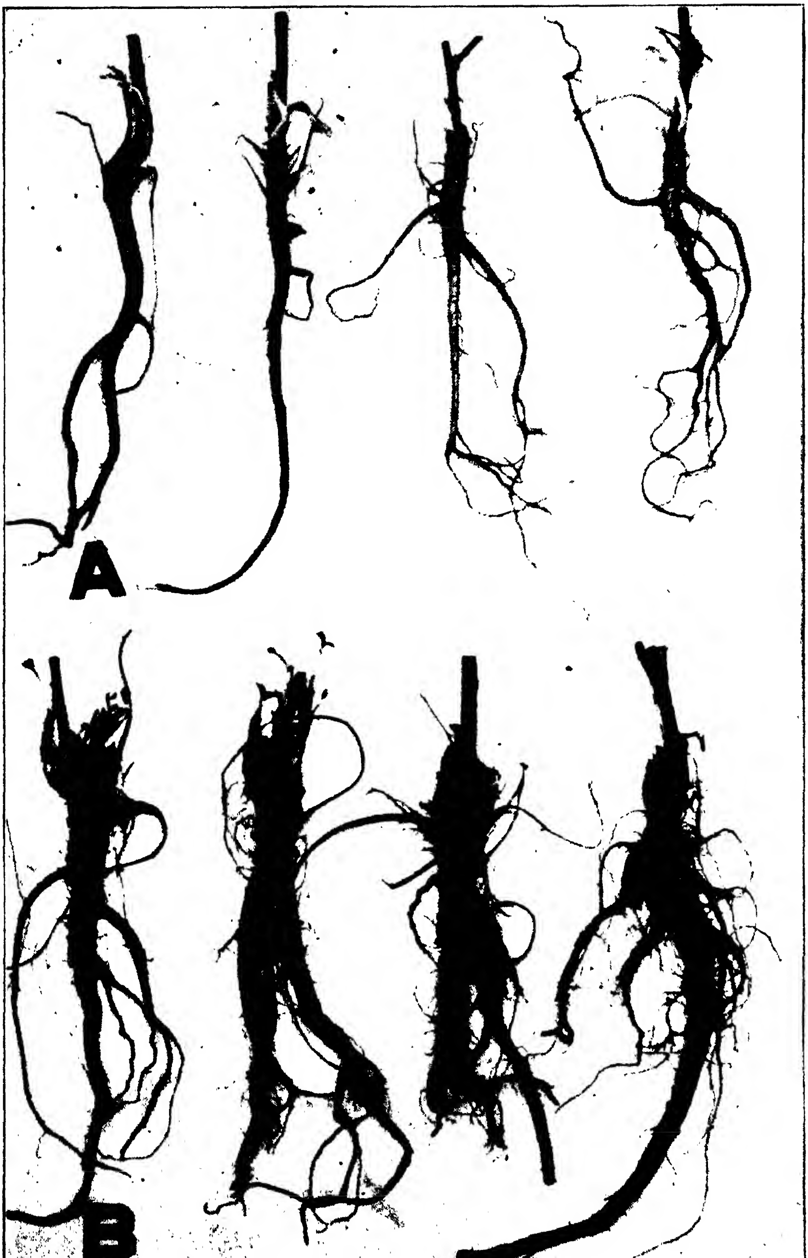

Fig. 1.—Roots of Sweet Clover, Nov. 13, 1927

A. Cut for hay September 9, 1927
B. Cut for hay November 3, 1927

Note difference in size and vigor of crown buds as well as of the roots

potatoes. This stunting of the roots is so remarkable that anyone can see it by leaving uncut a strip of a fall sweet clover field that he is cutting for hay, and then in November comparing the size of the roots of cut and uncut plants.

Table 1 summarizes data obtained from cutting first-year sweet clover at the Ohio State University.

TABLE 1.—Comparison of Sweet Clover Roots in November From Cut and Uncut Plots

Date of cutting hay	Air-dry roots per acre		Percentage of nitrogen		Nitrogen per acre in roots	
	Cut	Not cut	Cut	Not cut	Cut	Not cut
	Lb.	*Lb.*	*Pct.*	*Pct.*	*Lb.*	*Lb.*
September 17, 1924	1,120	1,680	3.09	3.52	35	59
September 25, 1925*	1,600	3,460	2.63	3.02	42	74
September 25, 1925*	2,470	3,400	2.89	3.21	71	100
September 28, 1925	770	1,730	2.90	3.38	22	58
September 26, 1926	830	1,530	3.33	3.53	28	51
Average 5 trials	1,360	2,160	2.97	3.33	39	68

*These two plots were sown alone in April on the Clermont County Experiment Farm. They had therefore made more growth on September 25 than plots sown with a nurse crop would have made.

Cutting reduces the soil-improvement.—For best results in soil improvement *well-grown* sweet clover should be plowed under from April 25 to May 10 of the second year (4, 5, 6). The nitrogen available for soil improvement at this time is almost entirely that which was fixed the preceding season. The amount of air-dry material and nitrogen found in these experiments with sweet clover cut for hay and not cut for hay the preceding year are shown in Table 2.

As an average of four years, the amounts of dry matter and nitrogen available for soil improvement early in the spring were more than cut in half by removing the hay crop in September of the previous year.

This discussion takes no account of the nitrogen in the fall hay crop itself. By the following spring only about one-sixth of this nitrogen remains in sweet clover tops left in the field (7). How much is retained by the soil has never been determined. But the feeding value of the fall hay is so much greater than its fertilizing value that the amount of nitrogen from the tops retained in the soil need not be considered in deciding whether to cut the fall hay crop or not.

Uncut fields can be pastured earlier.—The effect on the pasture value of the crop is nearly as remarkable. Sweet clover cut for hay the preceding September does not start off as rapidly in the spring

TABLE 2.—Comparison of Sweet Clover in Early Spring From Plots Cut and Uncut the Preceding September

Date of harvest	Date of cutting for hay	No. of samples averaged	Air-dry weight per acre, pounds						Percentage of nitrogen				Pounds nitrogen per acre					
			Cut for hay			Not cut for hay			Cut for hay		Not cut		Cut for hay			Not cut		
			Tops	Roots	Total	Tops	Roots	Total	Tops	Roots	Tops	Roots	Tops	Roots	Total	Tops	Roots	Total
Mar. 31—Apr. 7, 1923	Sept. 28, 1922	3	260	1,350	1,640	430	3,600	4,030	3.48*	4.51*	3.48	4.51	10	61	71	15	163	177
March 26, 1925......	Sept. 17, 1924	2	210	680	890	260	1,030	1,290	4.41	3.71	4.19	3.88	9	25	34	11	40	51
May 6, 1926..........	Sept. 28, 1925	1	360	670	1,030	1,140	1,150	2,290	3.60*	2.83*	3.60	2.83	13	19	32	41	30	74
April 6, 1927.........	Sept. 26, 1926	2	20	540	560	320	1,630	1,950	4.71	4.01	4.87	4.81	1	22	23	16	78	94
Average 4 years...	....	....	... ..	......	1,030	....	....	2,390	....	....	....	....	......	....	40	......	......	99

as that not cut, or cut very late. It is often possible to pasture sweet clover which was not cut in the fall, two weeks sooner than that which was cut for hay. The total growth produced during the season may not be very different, but the early growth is. Four uniform plots of sweet clover were sown in oats in April, 1926. One was cut for hay September 9, one September 26, one November 2, and one was not cut. Plants from these plots on May 2, 1927, are shown in Figure 2. Harvests made May 13, 1927, gave the following results:

AIR-DRY WEIGHT OF SWEET CLOVER MAY 13, IN POUNDS PER ACRE

	Tops	Roots
Cut September 9	340	160
Cut September 25	1230	620
Cut November 2	2370	980
Not cut	2120	990

The weight of crop harvested on the plot is a fair measure of its relative amount of pasturage.

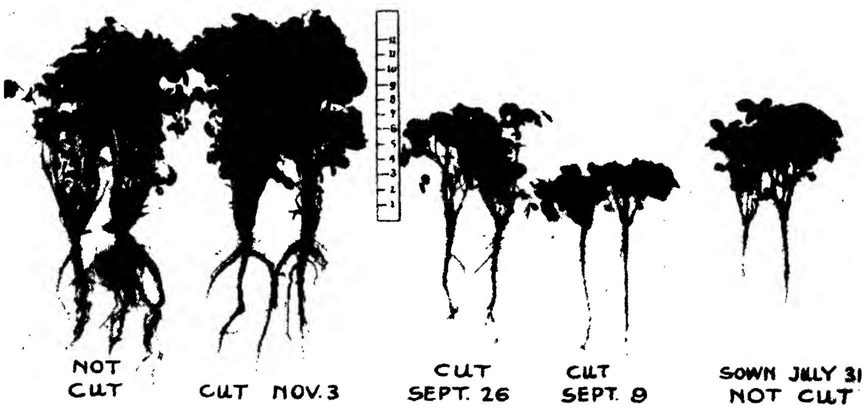

Fig. 2.—Two representative large plants from each of the clipping test plots, May 2, 1927

It was necessary to use the larger plants in order to make a comparison; the "average" plant in the plot cut September 9 was dead. The slightly shorter growth of the uncut plot as compared with that of the plot cut November 3 was due to the heavy mulch of stems which caused the soil to warm up more slowly than that of the cut plot.

Heaving was increased by removing the hay crop.—Cutting for hay may also result in winter-killing by heaving. When the crop was cut for hay early the roots were so small and poorly developed that they were heaved completely out of the ground and

the plants killed. The percentages of winter-killing on April 6, 1927, in the plots just described were as follows: Cut September 9, 75 percent; September 26, 53 percent; November 3, 12 percent, and not cut, 5 percent. By May the plot cut September 9 was practically devoid of sweet clover.

Root development important.—It seems that these effects were entirely due to differences in the amount of development of the root system. There was practically no injury from heaving or otherwise on the plot cut in November, nor was there in previous tests. The matter of winter cover does not seem to be important under Columbus climatic conditions. This dependence on the root development is emphasized by the fact that fields cut for hay behave like fields of summer-sown sweet clover, which is never able to store much material in the roots, (7) and which starts off slowly in the spring.

Under what conditions may the fall hay crop be removed?—These facts do not mean that the fall hay crop should never be removed. On many soils sufficient root growth is made by October 1 to carry the crop thru the winter and provide a good green manure crop for corn the next spring. The hay is equal to alfalfa and may be too valuable to waste. If a good growth is not made by October 1, because of poor soil or an unfavorable season, or if the greatest possible soil-improving value is wanted from a single crop, then the hay crop should not be cut.

Obviously, if some practical means could be found to preserve the tops about November 1, it would be possible to secure maximum root storage and also save the feeding value of the tops. Usually it is not practical to make hay at this time, but the later the hay is made the better for the sweet clover the next year. Making silage or heavy late pasturing on some farms may be a feasible method of saving the fall top growth.

Fall pasturing of sweet clover.—It is clear that early and heavy fall pasturing will have an effect similar to that of removing the hay, and it will be directly proportional to the earliness and intensity of the pasturing. Pasturing, which does not take all the tops at once, will not usually do as much harm as mowing. Nevertheless, Fraser's (2) suggestion that twice as much first-year sweet clover pasture be provided as is to be pastured the following spring, represents the best farm management.

Clipping sweet clover in August.—Many farmers mow their new clover seedings in August in order to kill weeds and get the stubble out of the way. This has little or no injurious effect on red

clover, which starts again from the crown. However, since sweet clover does not start from the crown, clipping is always a severe check to it, and may kill it entirely, especially if a dense stand is cut low. A sweet clover stand should not be touched with the mower after the nurse crop is cut, unless it is absolutely necessary in order to kill the weeds; then the cutter bar should be set high so as to leave as much of the sweet clover stem as possible.

SUMMARY

1. Cutting sweet clover for hay late in September reduced the amount of nitrogen available as green manure in April of the following year more than one-half, as an average of four years' experiments at Columbus.

2. The loss in a particular field will depend on the amount of root growth made before the hay is cut. The better the growth made before cutting and the *later* the hay is cut, the less is the loss.

3. Sweet clover cut for hay the preceding fall may be two weeks later than that not cut in making sufficient growth to pasture in the spring.

4. Cutting sweet clover for hay in September greatly increased its liability to winter killing by heaving. Cutting about November 1 has not resulted in winter killing at Columbus, but might possibly have an unfavorable effect under other conditions.

5. A first-year sweet clover seeding should never be clipped in August unless it is clear that weeds would destroy the stand if it were not clipped. Then the mower should be set as high as possible.

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DUST TREATMENTS FOR THE CONTROL OF STINKING SMUT OF WHEAT

R. C. THOMAS, W. G. STOVER, AND H. A. RUNNELS

It has been observed for several years that experiments conducted at Wooster for the control of stinking smut or bunt of wheat have not always been in agreement with similar tests at Columbus. The object of the series of tests started in the fall of 1925 was to determine, if possible, the reason for the discrepancies in the results of previous years, and to endeavor to secure uniformity of control that would serve as a basis for future recommendations.

Seed from the same lot was used for all tests. Thus a uniformity of spore distribution upon the grain was assured. A portion of the wheat treated at Wooster was retained for planting upon the Station farm, while the remainder was sent to Columbus to be included in the tests there. The same plan was followed with the seed treated at Columbus, a portion from each treated lot being retained for planting and the remainder sent to Wooster. The plots at Wooster were sown October 16, and those at Columbus, October 27, 1925.

The usual methods of applying the dusts to the grain were followed as in previous years when similar tests were conducted independently. At Wooster a rotary churn was used, while at Columbus the grain and dust were thoroly shaken together in a glass battery jar. Judging from outward appearances both lots of seed were equally well coated. The finer the dust the more easily the grain was coated and the more thoro the treatment.

There was a marked difference in the types of soil upon which the two series of tests were conducted. At Columbus the plots were upon a fine, sandy loam, rich in humus, nearly neutral or slightly alkaline; while those at Wooster were upon a clay type of soil, distinctly acid in reaction. No lime was applied to correct acidity.

The most outstanding variation noted in Tables 1 and 2 is the percentage of smut in the check plots, which were not given any treatment. Altho seed from the same lot was used for both series of tests the check plots at Wooster showed nearly three times as much smut as the plots at Columbus. Care had been taken to mix the grain thoroly before treatment to insure as uniform distribution

of spores as possible. It is likely that soil temperature had much to do in bringing about this variation. In the Wooster plots the seed germinated slowly and a considerable proportion of the plants did not appear above ground until the following spring. In spite of the fact that the plots at Columbus were planted more than a week later, germination was much more rapid and the period of susceptibility to infection was correspondingly reduced.

TABLE 1.—Wheat Treated at Columbus

Materials	Smut in plots at Columbus	Smut in plots at Wooster
	Pct.	*Pct.*
Check, untreated	14.6	41.7
Copper sulphate+lime, 3 oz. (anhydrous)	Trace*	0.4
Copper carbonate, pure, 3 oz.	Trace*	0.4
Copper carbonate, pure, 2 oz.	Trace*	0.2
Semesan 13 U. A. 2 oz.	5.0	1.4
Semesan dust, 2 oz.	....	1.5†
Wa Wa dust	Trace*	0.0
Bayer dust	1.9	0.6
Corona copper carbonate, 2 oz.	1.7	0.2
Corona copper carbonate, 3 oz.	.3	0.5

*Less than one-tenth of 1 percent.
†Used only at Columbus.

With the majority of the treatments used in both series of plots there was no great variation in the degree of control obtained. Attention is especially directed to the recognized standard dust treatments, comprising the various forms of copper carbonate and copper sulfate. Copper stearate used at the rate of 1 ounce per bushel afforded better control of smut on the acid soil at Wooster than at Columbus. There is no indication, however, that this form of copper should be substituted for the carbonate. Considering the

TABLE 2.—Wheat Treated at Wooster

Materials	Smut in plots at Wooster	Smut in plots at Columbus
	Pct.	*Pct.*
Check, new wheat untreated	41.7	14.6
Year-old wheat untreated	41.1	....
Copper carbonate, pure, 3 oz.	0.5	Trace*
Copper carbonate, pure, 2 oz.	0.5	Trace*
Corona copper carbonate, 3 oz.	0.4	0.1
Corona copper carbonate, 2 oz.	Trace*	Trace*
Bayer dust, 2 oz.	0.3	0.1
Semesan dust, 2 oz.	0.4	0.3
Sanders dust, 8.5% copper, 3 oz.	0.7	2.3
Copper stearate, 1 oz. per bu.	0.8	2.6
Copper stearate, ½ oz. per bu.	0.0†	....
Copper stearate, ¼ oz. per bu.	0.9†	....
Du Pont No. 37, 3 oz.	14.6†	....
Sanders dust 6.5% copper, 3 oz.	0.9†	....

*Less than one-tenth of 1 percent.
†Used only at Wooster.

cost of treatment and degree of control obtained, none of the dusts used showed any marked superiority over copper carbonate. From the standpoint of cost it was hoped that Sander's dust, primarily designed for dusting potatoes, could be substituted, but evidently the copper content is not sufficiently high. This dust, however, appears to be promising. In the Wooster plots the smut was reduced from 41 percent to less than 1 percent, while at Columbus the reduction was from 14.6 percent to 2.3 percent. It is evident that a dust carrying a high percentage of copper is not necessary. Nearly as good control was effected with Sander's dust carrying only 8.5 percent copper as with pure copper carbonate having more than 50 percent copper.

Both of these series of tests indicate that as good control of smut can be obtained from the use of 2 ounces of dust for each bushel of grain as from 3 ounces. In our previous recommendations we felt that treatment could be more quickly and easily made with 3 ounces than with 2 ounces. The object to be obtained in any case is thoro treatment, which means a complete coating of the grain. The degree of fineness of the dust, the humidity of the atmosphere at the time of treatment, and the method of treatment are factors which have a bearing upon the amount of powder to use.

EXPERIMENTS WITH MANURE IN HAMILTON COUNTY

J. S. CUTLER* AND W. E. WEAVER†

Despite the fact that manure has been used for centuries in increasing the yield of crops, there still remain many questions regarding its use which have not been fully answered. One of these relates to the proper distribution of manure among the crops of the rotation, especially where the supply is somewhat limited. Some results secured in the fertility experiments on the Hamilton County Experiment Farm bear upon this question, more particularly as applied to soils of like character in southwestern Ohio.

The common practice in the region on farms producing moderate amounts of manure is to apply all to the corn ground. This practice permits the hauling of manure directly from the stable to the field during the fall and winter months. On some farms where

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a larger part of the crops are fed to livestock and, consequently, larger amounts of manure are produced, it is not uncommon to apply a part of the manure to the wheat crop, usually as a top dressing during the winter months. Experience has shown that such top dressings often improve the stand of clover following the wheat crop.

In the Hamilton County experiments a rotation of corn, soybeans for seed, wheat and clover has been followed since 1913. On one plot shed manure has been used regularly on corn at the rate of 5 tons per acre, spread on the sod before plowing, and on wheat at the same rate applied as a winter top dressing. Another plot has received the same amounts of manure on corn and wheat supplemented with 16 percent acid phosphate at the rate of 200 pounds on each of the two crops. A third plot has received the same treatment with the addition of ground limestone on corn. The application of limestone was at the rate of 2 tons per acre up to 1922 and has been 1 ton per acre since that time. On another plot the corn has received manure, acid phosphate, and limestone at the same rate but the wheat has received a complete fertilizer equivalent to 320 pounds per acre of a 3-10-8 analysis, instead of manure.

TABLE 1.—Manure in the Hamilton County Experiments

Plot No.	Treatment	Applied to		Increase per acre				Value of increase†	
		Corn	Wheat	Corn 14-year average	Soybeans 12-year average	Wheat 13-year average	Clover 12-year average	Corn and soybeans	Wheat and clover
				Bu.	*Bu.*	*Bu.*	*Lb.*	*Dol.*	*Dol.*
8	Manure.........	5 T.	5 T.	15.47	2.56	7.87	1,449	14.67	20.71
9	Manure......... Acid phosphate	5 T. 200 lb.	5 T. 200 lb.	16.40	2.96	11.30	1,447	15.92	24.98
11	Manure......... Acid phosphate Limestone......	5 T. 200 lb. 1 T.*	5 T. 200 lb.	19.18	3.48	13.59	1,878	18.65	31.08
12	Manure......... Acid phosphate 3-10-8 fertilizer . Limestone......	5 T. 200 lb. .... 1 T.*	.... 320 lb.	19.09	3.12	13.32	1,165	18.04	25.39

*The limestone application was at the rate of 2 tons per acre up to 1922; beginning with 1923 the application was reduced to 1 ton per acre.

†Prices used in figuring values of crop increases: corn with its stover, 70¢ per bu.; soybeans with straw, $1.50 per bu.; wheat with its straw, $1.25 per bu.; clover hay, $15.00 per ton.

In Table 1 are shown the crop increases secured on each of these plots. In computing the value of the crop increases, the values of the increases in the corn and soybean crops are combined and credited to the treatment given the corn crop, and the values of the increases in wheat and clover are credited to the treatment

given the wheat. While the residual effect of a manure or fertilizer treatment is known to persist longer than two years, a comparison of the values of the increases, combined as shown, probably gives a fair indication of the relative values of treating the two crops, corn and wheat.

On Plot 8, receiving 5 tons of manure on both corn and wheat, the application given to the corn crop has to its credit crop increases valued at $14.67, whereas the application to wheat has to its credit $20.71, its superiority being due in large part to the greater residual effect on the clover as compared to the soybean crop.

The effect of supplementing the manure with acid phosphate when applied to the corn has been to produce relatively small additional increases in the yields of corn and soybeans, their combined value being $1.25; when applied to the wheat, a relatively larger value of increase, $4.27, represented entirely by a 3.43 bushel increase in the yield of wheat. Apparently, on this soil, two 5-ton applications of manure have provided nearly all the phosphorus needed for corn, soybeans, and clover, but not enough for miximum yields of wheat.

The only difference in the treatment given Plots 9 and 11 has been the application of limestone on Plot 11. The differences in yields, presumably due to the limestone treatment, have been: corn, 2.78 bushels; soybeans, .52 bushel; wheat, 2.29 bushels; and clover, 431 pounds—increases having a total value of $8.82 for the rotation. If now, it is assumed that the same amount of limestone used on Plot 12 has been responsible for equal increases and if the increases due to liming are deducted from the total ncreases produced on this plot, there remain 16.21 bushels of corn and 2.60 bushels of soybeans with a combined value of $15.25 to be credited to the manure and acid phosphate applied to the corn, and 11.03 bushels of wheat and 734 pounds of clover hay with a combined value of $19.30 to be credited to the complete fertilizer applied to the wheat.

A comparison of the value of the increases resulting from the use of a complete fertilizer on wheat on Plot 12 with the value of the increases from an application of 5 tons of manure to wheat on Plot 9, shows a difference of only $1.41 in favor of the manure treatment. The fertilizer has given the larger increase in yield of wheat, while the manure has had a better effect on the clover. The fertilizer at present prices for commercial mixed goods would cost about $6.35. This is considerably less than the market value of 5 tons of manure and probably not much more than the bare cost of hauling and applying the manure. It seems fair to assume, therefore, that on

farms where the amount of manure is not sufficient to provide for an application to both corn and wheat, the manure might best be given to the corn crop, and commercial fertilizers to the wheat.

A 2-16-2 analysis is suggested for soils in fair to good condition, and a 3-12-4 analysis for soils of low productivity. These analyses are considered superior to the 3-10-8 analysis used in the Hamilton County experiments, since they contain more phosphoric acid and less potash, this being in line with the known response of wheat to these two elements. Where the supply of manure is more plentiful, a winter top dressing on wheat is probably advisable. This should be supplemented with a liberal application of acid phosphate, preferably applied at seeding time.

Whether or not the manure applied to corn should be supplemented with acid phosphate will depend upon the liberality of the fertilizer treatment given the wheat. The wheat crop should in general receive the larger part of the fertilizer used in the rotation, unless potatoes or tobacco is included. With liberal use of fertilizers on the wheat, and where some manure is applied on the corn, it is suggested that the fertilizer treatment for corn be limited to the use of around 100 pounds per acre of acid phosphate or 2-16-2 applied in the hill or row thru the fertilizer attachment of the corn planter.

SOLVING THE GREEN FEED PROBLEM

D. C. KENNARD AND R. M. BETHKE

The major problem of successful poultry feeding revolves around the effective use of green feed and direct sunlight or their equivalents. Success or failure in poultry feeding often depends upon the solution of this problem. To provide green feed is sometimes a difficult and expensive part of the ration. However, regardless of the expense, failure adequately to provide both green feed and sunlight may mean a much greater loss in the end than any necessary expense involved in securing them or effective substitutes. Attention to these essential factors is often the reason why certain poultry keepers in a community succeed while others about them fail.

During the spring and summer the best and most practical solution of the problem is a good outdoor range. A good range of

bluegrass, clover, or alfalfa is the best supplement for any ration. Certainly every poultry keeper should take full advantage of nature's valuable contributions. However, "keeping close to nature" often does not serve the needs of the poultry keeper whose modern methods lead to a high degree of intensification. Where large numbers of birds are kept it becomes difficult if not impossible to maintain a green range and to avoid disease and parasitic contamination of the soil. Since a commercial poultry plant cannot be made portable, the asset of an adequate natural range usually must to some extent be sacrificed. Then the question of supplying green feed and direct sunlight or their equivalents by other means becomes a pertinent one.

The summer growth of pullets depends upon the open range, which should be provided without exception, unless it be the "backyarder". Whenever 100 or more pullets are to be raised they should have an exclusive range, away from the mature stock. This range should yield an abundance of green forage and provide ample shade. The pullets should be housed in portable colony houses that can be moved to fresh ground each year and moved during the summer one to three times, depending upon the number of birds and the nature of the range. The summer range conditions have a direct influence on the kind and value of pullets to be expected in the fall and may determine the poultry keeper's success or failure. It is usually a comparatively simple matter to maintain an open range exclusively for summering growing pullets that will provide an abundance of green forage and at the same time avoid soil contamination.

Unfortunately it is not so easy to provide for the large number of layers kept in permanently located houses all the year. Green forage may be available for a few months during the spring and early summer and supplemented by other sources of green feed as required, but soil contamination is a continuous problem. A carefully managed system of double yarding and the alternate growth of suitable forage offers a partial solution.

The previous use of the range and the decreased rainfall after June often deplete the natural forage. The range may then be supplemented by early cabbage, swiss chard, or summer spinach. These may be fed until December or later.

This brings us to the real problem—the provision of winter green feed or its equivalent. Succulent green feed does not grow under natural conditions then nor can the range be depended upon to supply it during the winter months. To store succulent green

feed is expensive and not very satisfactory, nor can it be fed to advantage during freezing weather. Is there a better way?

Legume hays as substitutes.—High quality, leafy legume hays have proved to be satisfactory equivalents of green feed. Alfalfa, red clover, and soybean hays appear to be about equally valuable. In the various feeding trials conducted by the Station to determine whether there are any satisfactory substitutes for succulent green feed, surprisingly favorable results were secured by the use of legume hays.

The hay may be fed in various ways. Perhaps the best way is to cut it in ½ inch lengths by passing thru a cutter. It can then be put into a wire-netting basket feeder and kept before the birds all the time. Uncut hay may be put into feeding racks made of plaster lath placed vertically 2 inches apart. Still another way is to tie the hay in a bundle and suspend it from the ceiling so as to be 5 or 6 inches from the floor. From November to May about six pounds of hay will be required for each bird.

Alfalfa, red clover, and soybean hays are satisfactory. Regardless of the kind it is necessary that the hay be made of the immature plant so as to carry a large proportion of leafy material, which contains the constituents valuable for chickens. The hay must be carefully cured without getting wet, so that it will hold its bright green color. This insures the retention of its valuable water soluble constituents. It may sometimes be necessary to cure the hay inside, altho sun-cured hay is regarded as being superior in some respects to that cured without exposure to direct sunlight. Usually the second or third cuttings of alfalfa and clover are best. Soybean hay is best cut when the seeds are just beginning to form in the pods. At this stage the hay is leafy, palatable, has a high protein content, and gives a fairly good yield.*

Alfalfa leaf meals.—Many poultry keepers who do not have the proper quality of legume hay, may desire to add ground alfalfa to the mash instead. Adding the ground product to the mash has the advantage of some convenience, but the principal advantage is that it can be readily obtained when the proper quality of hay may not be available. The disadvantage of the commercial product is that its quality may vary without being easily detected, whereas, the difference in quality of hays is evident. The Station's tests with the use of ordinary alfalfa meal in the mash indicated no benefit from its use. Recently higher quality alfalfa leaf meals, made principally from the leafy portion of good quality alfalfa hay, have

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*Details as to time of cutting and handling soybean hay are given in Bulletin 384 of the Ohio Experiment Station.

become available and they offer promise, according to tests now in progress, of being a satisfactory substitute or equivalent for the hay. The alfalfa leaf meal may be used in the mash at the rate of 5 to 10 percent by weight.

There are three important indexes which indicate the quality of alfalfa leaf meal—its color, protein content, and fibre content. The color should be of a rather bright pea green and the protein should not be less than 20 percent nor the fibre more than 18 percent. Ordinary alfalfa meal will usually have a lighter, yellowish color with a protein content of about 14 percent and a fibre content of 30 to 35 percent. No benefit should be expected from the addition of this kind of product to the mash.

Direct sunlight.—Cod-liver oil may be used to supplement or largely replace direct sunlight. However, if possible, direct sunlight should be admitted thru open front spaces. When weather conditions require that the house be kept closed it is advisable to use, instead of window glass, a glass substitute that will admit a large proportion of the beneficial rays of sunlight. In sections of the country where there is considerable sunshine and a rather mild climate undoubtedly the better plan would be to give the chickens the benefit of a range of blue grass or rye and the incidental exposure to the direct sunlight during the winter months. In other sections where the winters are more severe and there is little sunshine so that the use of the outside range can not be depended upon, many poultry keepers will find it desirable, if not necessary, to confine the layers inside from November to April and supplement the ration with the equivalents of outside range or green feed and direct sunlight.

EQUIVALENTS FOR GREEN FEED AND SUNLIGHT

What are the equivalents of green feed and direct sunlight and how are they supplied? For several years the Ohio Experiment Station has been giving much attention to this question which vitally concerns every poultry keeper. Research and extensive feeding investigations have brought out some useful information which is already proving effective in actual practice. Briefly the results are as follows:

Feeding tests.—The groups of layers fed the legume hays of proper quality laid practically the same number of eggs from November to May and of as good hatchability as similar groups of birds having the same ration but with access, when weather permitted, to an outdoor range of blue grass instead of the legume hay.

In contrast to this, similar groups of layers receiving the same ration but without the legume hay or outdoor range, laid only 70 percent as many winter eggs and the average hatchability of the eggs was reduced from 57 to 36 percent. These results (see Table 1) were derived from two years' work conducted with nine different groups of 50 layers each. The hatchability tests were based on nine different hatches the first year and thirteen the second year. A third year's tests now in progress are substantiating the first two years' results.

Taken as a whole the Station's tests conclusively prove the value of a high quality leafy alfalfa, red clover, or soybean hay as an equivalent for succulent green feed for winter use. The legume hays are not only effective, but they can be provided with less labor and expense and can be fed to advantage without interruption during the coldest weather.

Winter egg production and hatchability of the eggs from the layers confined indoors and fed the legume hay and of the layers having access to an outdoor range of blue grass were comparable. However, it should be emphasized that this applies only to the months of November to April, inclusive. From May to November the birds having the outdoor range of blue grass fared much better—they laid more eggs with less mortality, Table 1. This was to be expected for the outdoor range is often of uncertain value during the winter. That is, legume hays will serve as an equivalent of green feed or outdoor range when the range and green feed are at their lowest point of value and when an alternative is most needed. But during the balance of the year the birds should be given the advantage of the best possible outdoor range conditions if best results are to be secured. This fits well with poultry practice.

Cod-liver oil.—In the consideration of equivalents for green feed and outside range, cod-liver oil deserves an important place. In fact it may partially serve the purpose of green feed and, if the oil is of proper quality, it is very potent in vitamin D and thereby may serve as an effective equivalent for direct sunlight. While cod-liver oil to some extent substitutes for green feed, it should be emphasized that green feed possesses some valuable properties, such as minerals, other vitamins, and fibre not supplied by the oil. Extensive tests by the Ohio Station show that in case of layers confined indoors during the entire year or even during the winter months, a marked increase in egg production and reduction of mortality resulted when 2 percent of cod-liver oil was added to the ration. A surprising improvement in shell texture of eggs was

secured, proving it a positive prevention or remedy for weak shelled eggs and the incidental vice of hens' eating their eggs.

Just as surprising is the fact that, along with these benefits from the use of cod-liver oil, the tests revealed no improvement in the hatchability of the eggs. Two experiments with 50 breeders to each group in 1925 and a third test in 1926 involving a total of 1500 eggs and the 9 or 13 different hatches from each group gave an average hatchability of 32 percent for the cod-liver oil as against 36 percent for the same basal ration without cod-liver oil. Similar groups of birds fed legume hays averaged 54 percent and those on blue grass range averaged 60 percent.

Since green feed and legume hays are all low in vitamin D and at the same time supply the best source of other vital factors in the ration, and cod-liver oil serves as the most potent source of vitamin D, or the direct sunlight factor, it seems obvious that during the winter months the most effective equivalent for green feed and direct sunlight, or the outdoor range, should be the proper combination of legume hay and cod-liver oil. This is supported by experimental evidence, and it is now the practice of the Ohio Station to use both these supplements when it is desired to supply a complete ration to chickens confined indoors.

With present information, a schedule of procedure can be arranged for the entire year that will effectively solve these difficulties that have proved such a handicap in the past. This schedule involves the proper and judicious use of the outdoor range, succulent green feed, legume hays, direct sunlight, and cod-liver oil in their various combinations according to special conditions and the season of the year.

TABLE 1.—Egg Production and Hatchability as Affected by the Use of Legume Hays and Blue Grass Range

Ration	Eggs per bird Nov. 1 to		Increase of eggs over basal ration	Mortality	Hatchability		
	Mar. 1 4 mo.	Oct. 1 11 mo.			Eggs set	Fertile	Chicks hatched
Experiment 1 1924–25	*No.*	*No.*	*Pct.*	*Pct.*	*No.*	*Pct.*	*Pct.*
Basal ration only	29	95	....	44	530	94	31
Basal ration plus alfalfa hay chopped	39	125	32	12	645	94	42
Basal ration plus bluegrass range	36	159	67	8	1,007	98	62
Experiment 2 1925–26							
Basal ration only	27	90	....	22	906	95	36
Basal ration plus alfalfa hay chopped	31	137	52	18	1,354	95	59
Basal ration plus red clover hay chopped	34	125	39	32	1,026	96	55
Experiment 3 1925–26							
Basal ration only	19	89	....	40	325	76	31
Basal ration plus soybean hay chopped	38	138	55	26	637	82	61
Basal ration plus bluegrass range	37	170	91	10	944	73	60

THE ANTI-RACHITIC PROPERTIES OF COD-LIVER MEALS

R. M. BETHKE

In the manufacture of cod-liver oil there remains a liver residue which is dried and sold in the open market under the name of "Cod-liver Meal". This by-product is creating a great deal of interest among poultrymen and poultry feed manufacturers as to its feeding value. It has been claimed that it possesses, among other properties, factors that will prevent leg-weakness.

Science has shown that cod-liver oils vary greatly in their vitamin content. This residue after the partial extraction of the oil may likewise be expected to vary in vitamin potency. The heat employed in drying the liver residue may exert a further effect in attenuating its vitamin content. It thus seemed logical to inquire into the anti-rachitic properties of this product.

For this purpose five lots each of 62 day-old White Leghorn chicks from the Station's flocks were placed in similar indoor pens where no direct sunlight could reach them. Lot 1 was fed a mash of yellow corn 57 parts, wheat middlings 20, dried buttermilk 15, meat meal 5, calcium carbonate 2, and salt 1. Lots 2, 3, and 4 received a similar ration in which the 5 parts of meat meal in each was replaced by an equal quantity of a different cod-liver meal. The ration of Lot 5 was similar to that of Lot 1 with the addition of 2 parts cod-liver oil. All groups were cared for alike. Pine shavings, changed weekly, were used as litter. Water was given as a drink.

The chicks in all groups were continued on experiment for six weeks, when 12 representative birds from Lots 1, 2, 3, and 4, and 6 from Lot 5, were killed for bone analysis. The tibias of these birds were removed, freed from adhering tissue, dried, extracted with hot alcohol and ether, and subsequently ashed in an electric muffle furnace. The data for the five groups are recorded in Table 1.

From an inspection of the results (Table 1) it is evident that the three cod-liver meals varied in the properties that prevent leg-weakness. Cod-liver meal B fed Lot 3 exerted practically no anti-rachitic effect over meat meal fed Lot 1 as attested by the number of cases of leg weakness and the ash content of the tibias. Cod-liver meal A, on the other hand, proved better than meal B, altho less efficient than meal C. While affording the greatest protection of the three meals, C did not prove equivalent to 2 percent (Lot 5) of cod-liver oil.

A chemical analysis of the three cod-liver meals revealed a marked variation in their residual fat content, cod-liver meal C analyzing approximately 44 percent ether extract in contrast to 30 percent for meal A and 23 percent for meal B. It thus appeared that the amount of protection against leg-weakness might be proportional to the ether extract. However, when the three meals were fed on the same extract basis it was definitely proved that the degree of protection bore no relation to the ether extract. Apparently the source of the meal and its probable method of manufacture influence its anti-rachitic properties. These points are being investigated further.

TABLE 1.—Cod-liver Meals as Preventives of Leg Weakness in Chicks

Basal ration, all lots alike: yellow corn 57 parts, wheat middlings 20 parts, dried buttermilk 15 parts, meat meal 5, calcium carbonate 2 parts, and salt 1 part

Age	Lot 1 Control		Lot 2 5 percent cod-liver meal A		Lot 3 5 percent cod-liver meal B		Lot 4 5 percent cod-liver meal C		Lot 5 2 percent cod-liver oil	
	Average weight	Leg weakness	Average weight	Leg weakness	Average weight	Leg weakness	Average weight	Leg weakness	Average weight	Leg weakness
Weeks	*Gm.*	*No.*	*Gm.*	*No.*	*Gm.*	*No.*	*Gm.*	*No.*	*Gm.*	*No.*
1	55.9	0	52 7	0	52.2	0	49.6	0	50.3	0
2	75.2	0	69 6	0	68.1	0	67.7	0	74.8	0
3	104.4	17	108 3	2	100.9	10	109.0	0	113.1	0
4	132.4	26	146.6	7	131 1	18	163.0	0	160.9	0
5	160.5	25*	201.1	16	158.4	26	221.8	0	218.7	0
6	189.8	25	238.4	18	175.6	26	268.1	1	279.6	0
Av. percent ash in tibias	32.23		39.19		32.32		44.14		47.61	

*One chick died.

GOLDEN DELICIOUS APPLE—ITS SPRAYING, PICKING, AND STORAGE

C. W. ELLENWOOD

No variety of apples introduced into Ohio has received more consideraton than the Golden Delicious. It has been planted in all sections of the State, and trees are now fruiting in many orchards.

The quality and flavor of this variety as grown in Ohio place it in a class with Grimes Golden. However it has been observed quite generally that the variety shrivels badly in cellar and cold storage. In fact this weakness has been so serious as to be a reason for not including it in a list of recommended commercial varieties.

Three lines of work have been started by the Experiment Station to determine to what extent this weakness of the variety can be corrected: first, the use of dilute summer sprays; second, the determination of the best picking dates for the variety; and third, the use of waxed wrappers and waxed shredded paper in storage.

This is a preliminary report of these tests. The results thus far will serve as a basis for further study and observation.

THE USE OF DILUTE SPRAYS

It was early observed that Golden Delicious, like Grimes, is very easily russetted by fungicides used at the ordinary strengths in the summer applications and, like that variety, it has not been seriously attacked by apple scab.

As a result of the roughening and russetting of the skin and the absence of the oily secretion which prevents evaporation, shriveling usually has occurred early in the season.

Experiments and practice have shown that the use of hydrated lime in connection with arsenate of lead for all the after-blossom sprays gives a much better finish to Grimes than the use of even dilute solutions of lime-sulfur. The program found advisable in the case of Grimes suggested itself for eliminating spray russet in Golden Delicious. The result was a distinct improvement in the finish of the fruit. All summer sprays have been made up of hydrated lime 5 or 6 pounds plus arsenate of lead 1¼ pounds to 50 gallons of water.

PICKING DATES

The specimens for the storage tests were carefully picked and placed in bushel baskets in cellar storage either the day picked or the following day. Only well colored specimens were stored.

Since Golden Delicious attains a good rich color almost as early as Grimes, it is often picked at the same time. However, it will hang on the tree until late in the season and, as will be shown, the picking dates are considerably later than Grimes.

The importance of the time of picking Golden Delicious in its relation to shriveling has been observed by growers and experiment station workers almost from the first.

In 1925 and 1926 Golden Delicious was picked on dates varying from the Grimes' picking season to three weeks later. The picking dates of Grimes at Wooster in 1926 ranged from the 12th to the 18th of October, 10 days to 2 weeks later than normal. The Golden Delicious was picked October 18 and placed in cellar storage the same day. When examined January 28, 30 of the 81 specimens were shriveled. Grimes picked at the same time and stored under the same conditions showed only 2 shriveled fruits out of 123 specimens. Golden Delicious picked October 18 were also wrapped in waxed and tissue paper. Wrapping decreased the amount of shriveling but did not eliminate it as there was on January 28 in each kind of wrapper about 12 percent of shriveled fruit.

Apples picked October 25 when examined January 28 showed decidedly fewer shriveled specimens even in the lot which were not wrapped.

Those picked November 2 and stored the same day, when examined January 28, showed practically no shriveling in wrapped or unwrapped specimens.

These tests are only preliminary and meager but they at least indicate that the proper picking date for Golden Delicious is from 10 days to 2 weeks later than Grimes Golden.

THE USE OF WRAPPERS

In addition to picking Golden Delicious at different dates, specimens were as previously indicated stored in plain tissue and others in waxed wrappers. In every case wrapping, whether in plain tissue or waxed paper, decreased the amount of shriveling. However, Golden Delicious picked in the Grimes' season, October 18, shriveled even when wrapped in waxed paper.

The value of wrapping became apparent only with the fruit picked 10 days or 2 weeks later than the Grimes. Waxed wraps did not significantly reduce shriveling. Specimens stored in covered bushel baskets thru which shredded waxed paper was scattered came out on January 28 in as good condition as those in waxed wrappers.

A second examination, March 2, a month past the commercial season of the variety, showed less shriveling among the lots wrapped with waxed paper than in those wrapped with plain tissue paper. Specimens stored in baskets in which the shredded waxed paper was scattered kept in as good condition until March 2 as those wrapped with waxed paper. The general appearance of the apples stored in either waxed wrappers or in shredded waxed paper was much better than those wrapped in plain tissue paper.

CONCLUSIONS

The following conclusions may be made from these preliminary tests. First, Golden Delicious should be sprayed with lime and lead only on all after-blossom sprays.

Second, Golden Delicious should not be picked until 10 days or 2 weeks after the optimum season for picking Grimes.

Third, wrapping in waxed paper or packing in shredded waxed paper will materially aid in the prevention of shriveling.

OHIO FARM INCOMES FOR 1926

C. R. ARNOLD

Farm incomes in the United States are still considerably below those in many other industries, but in some sections at least they have been showing signs of improvement during the last year or two. Ohio farmers, because of our geographic location and type of farming, are in better shape financially than those in some of the other states. The prices of cotton and corn were exceptionally low last year, but the Ohio farmer sells no cotton and most of his corn is marketed thru dairy cows or hogs, prices of both of which were fairly good during 1926.

However, the price of the product does not tell the whole story, for much depends upon the amount one has to sell as well as the price received. A far better index of the farmer's prosperity is shown by the actual money taken in or by the amount left after paying all of the farm expenses.

During the past winter approximately 400 farmers thruout Ohio brought their account books to some central point in their county and spent the day figuring their incomes and analyzing their

records to discover the strong and weak points in their farm business. Naturally these men who are studying and analyzing their business from year to year are more efficient and are making a larger income than the average farmer. Only 16 of the 257 of these records at present analyzed, fail to show some net income after all farm expenses are paid and interest on all of the capital invested in the farm business is allowed. The average labor income of these 257 farms was $1389, with cash receipts of $3766 and cash expenses of $1622.

In 1925 records of 126 farms in western Ohio showed an average cash receipt of $3753 and cash expenses of $1775. Records for 1926 on 231 farms that have been tabulated to date show average cash receipts of $3958 and cash expenses of $1696. These did not include all the farms of 1925, but covered the same general area of the State.

On 72 of these farms complete records have been tabulated for both 1925 and 1926. An analysis of their financial operations gives a good indication of the changes in income which have taken place on the better farms of Ohio during the last two years.

AVERAGE RECEIPTS, EXPENSES, AND INCOME OF 72 OHIO FARMS

	1925	1926
Cash receipts per farm	$3288	$4153
Cash expenses per farm	1509	1626
Labor income per farm	1189	1607

These were the same farms and operated by the same men both years. The figures show that the operator's wage of these men was $418 more in 1926 than in 1925.

The gain in income here is made possible thru a considerable increase in cash receipts per farm with only a slight increase in cash expenses. Good farmers are making fairly good incomes in Ohio, but there is a greater difference between the average income of good farmers and that of farmers who are not studying and improving their business than ever before.

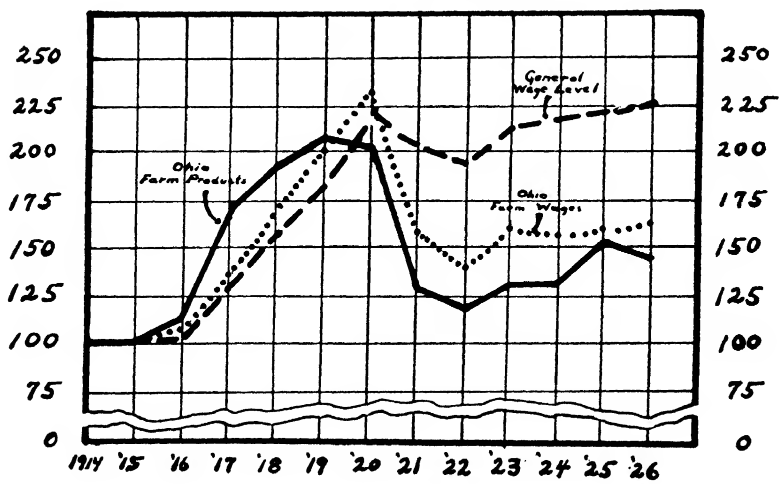
FARM WAGES IN OHIO

J. I. FALCONER

Some 50 percent of Ohio farms hire no labor, about 25 percent hire for somewhat less than a year's time, while the other 25 percent hire one or more men the year around. Such data as are available indicate that there is only about one-half the amount of hired labor on Ohio farms that there was in 1910.

Not only is farm labor becoming scarce but it commands a higher wage, at least when compared with former days, or when compared with the prices of farm products in the State. The accompanying chart shows the level of farm wages in Ohio, factory wages in New York State, and the prices of Ohio farm products. It will be noted that up to 1920 farm wages advanced more rapidly than city wages and that up to that time the prices received for farm products advanced more rapidly than wages. Following 1920 farm wages fell with the price of farm products. City wages, however, showed a slight tendency to decline, then to rise, and by 1926 had reached a level higher than that of 1920.

THE LEVEL OF GENERAL WAGES, OHIO FARM WAGES, AND OHIO FARM PRODUCTS 1914 - 1926



It is this situation, namely, the high wages paid in city employment on the one hand and the low price received for farm products on the other hand, which has attracted labor from the country to the city and made it difficult for the country to meet the situation by paying equally high wages.

CARLOT UNLOADS OF APPLES IN FOUR OHIO CITIES

C. W. HAUCK

Complete data as to the disposition of Ohio's apple crop or as to the source of all the apples consumed in Ohio are not available. For the past few years, however, statistics have been collected covering the carlot receips of apples in the four largest Ohio cities, namely, Cleveland, Cincinnati, Columbus, and Toledo. In the following table are given the average annual carlot unloads of apples in these four cities from 1924 to 1926, by states of origin:

Carlot Unloads of Apples in Four Ohio Cities
3-year average, 1924-1926

State of origin	Cleveland	Cincinnati	Columbus	Toledo	Total in four cities
	Cars	*Cars*	*Cars*	*Cars*	*Cars*
New York........	724	537	116	89	1,466
Washington.....	571	349	76	74	1,070
Ohio.	37	30	175	27	269
West Virginia........	71	55	94	6	226
Michigan..............	28	76	3	77	184
Virginia.............	38	58	6	5	107
Illinois..................	37	44	7	11	99
All others.	140	186	46	26	398
Total......	1,646	1,335	523	315	3,819

During the last three years these cities have received annually by rail an average of 3819 carloads of apples. Only 269 of these, about 7 percent, have come from points within the State. Most of them were shipped into Ohio from New York and Washington. Cleveland and Cincinnati receive only about 2 percent of their apples (in cars) from Ohio points, a smaller proportion than in either of the other two cities. This is due partly to the much larger total number of cars of apples unloaded there than in Columbus or Toledo, and partly to the fact that the actual number of cars of Ohio apples shipped to Cleveland and Cincinnati is small. Toledo takes almost as many cars from Ohio as either Cincinnati or Cleveland, and Columbus takes a considerably larger number than any of the others. More than 33 percent of the carlot receipts in Columbus are from Ohio points, due no doubt to the proximity of Columbus to the apple producing region of southeastern Ohio.

During the same three years there were 1010 carloads of apples shipped from Ohio points, just how many of these were shipped to Ohio markets is not known. For the last eight months of 1926,

however, the records show 618 carloads of Ohio apples shipped by rail, of which 484 were consigned to Ohio points.

These figures, it must be kept in mind, relate only to carlot shipments and make no record of the large volume of Ohio grown apples which find their way to local markets by truck, automobile, or wagon, or are consumed or otherwise disposed of at home.

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

The decline in general price level still continues. The Cleveland Trust Company in its May Business Bulletin comments: "There is no doubt that the country as a whole is enjoying an era of exceptional prosperity, which has lasted, with only brief interruptions, since the latter part of 1922. Our national income is nearly three times as great as it was just before the war. Employment is general and the purchasing power of the industrial worker's wages is greater than it has ever been before, either in this country or in any other. The volume of industrial profits is greater than at any previous time.

"It is becoming apparent that protracted prosperity during a period of declining commodity prices produces the keenest kind of business competition. This is an unexpected development for we have never previously experienced a long period of prosperity during which the general level of commodity prices persisted in declining".

It seems that in industry, high profits are being maintained mainly by reducing costs and by increasing efficiency in production and marketing. It is among the smaller concerns that failures are increasing. From January, 1926 to April, 1927, the price of non-agricultural products declined from a level of 165 to 152, while Ohio farm product prices declined from 156 to 144. Agriculture, therefore, is not alone in having to meet a declining price level and agriculture like industry seems to be meeting the situation by the same means.

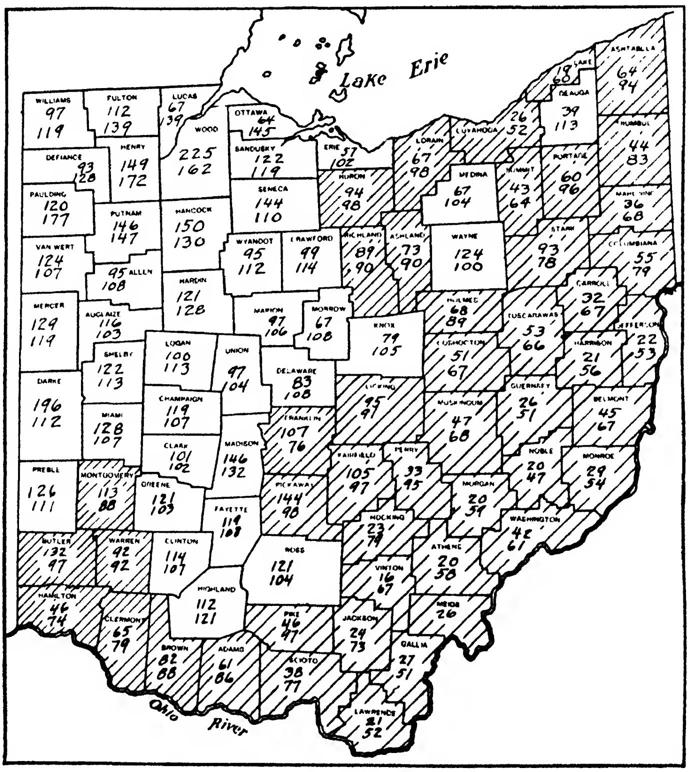
TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Non-agricultural products U. S.	Farm products prices U. S.	Ohio farm wages	Prices Ohio farm lands	Farm products prices Ohio
1913	102	...	105	100	104	...	104
1914	100	100	97	102	102	...	105
1915	103	101	101	100	103	100	106
1916	130	114	138	117	113	104	121
1917	181	129	182	176	140	111	182
1918	198	160	188	200	175	119	203
1919	210	185	199	209	204	126	218
1920	230	122	241	205	237	146	212
1921	150	203	167	116	164	122	132
1922	152	197	168	124	145	109	127
1923	156	214	171	135	166	108	134
1924	152	218	162	134	165	104	133
1925	161	223	165	146	165	97	159
1926	154	228	161	136	170	96	155
1926							
January	159	229	165	143	160	...	156
February	158	225	164	143	...	96	156
March	154	229	162	140	...	...	155
April	154	227	160	140	167	...	157
May	154	226	160	139	...	...	161
June	155	228	160	139	...	...	161
July	154	227	159	136	176	...	158
August	152	227	160	133	...	...	149
September	154	231	161	134	...	...	149
October	153	231	160	130	177	...	150
November	159	230	161	130	...	...	154
December	150	232	158	127	...	...	151
1927							
January	150	232	156	126	169	...	145
February	149	231	155	127	...	...	145
March	148	234	153	126	...	90	144
April	147	...	152	126	172	...	144
May	...	...	...	...	...	...	...

LAND UTILIZATION IN OHIO

J. I. FALCONER

It is interesting to note that, while there has been little change in the total area of land in Ohio in crops other than hay since 1890, the distribution of this acreage in the State has shifted. In 1890 the census reported an area of 7,129,994 acres for crops other than hay crops; in 1924 this acreage was 7,154,670, a net increase of 29,676 acres. Between these dates 49 counties showed a decrease and 39 counties an increase in area. The total increase in the 39 counties was 698,321 acres; the total decrease in the 49 counties 668,645 acres. Nearly all the eastern Ohio and Ohio river counties showed a decrease of land in crops while western Ohio showed an increase. Paulding County's increase of 77 percent was the greatest percentage increase in area, and Noble County's decrease of 53 percent the greatest decrease. These figures refer only to crops other than hay and do not include pasture.



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Ohio Agricultural Experiment Station

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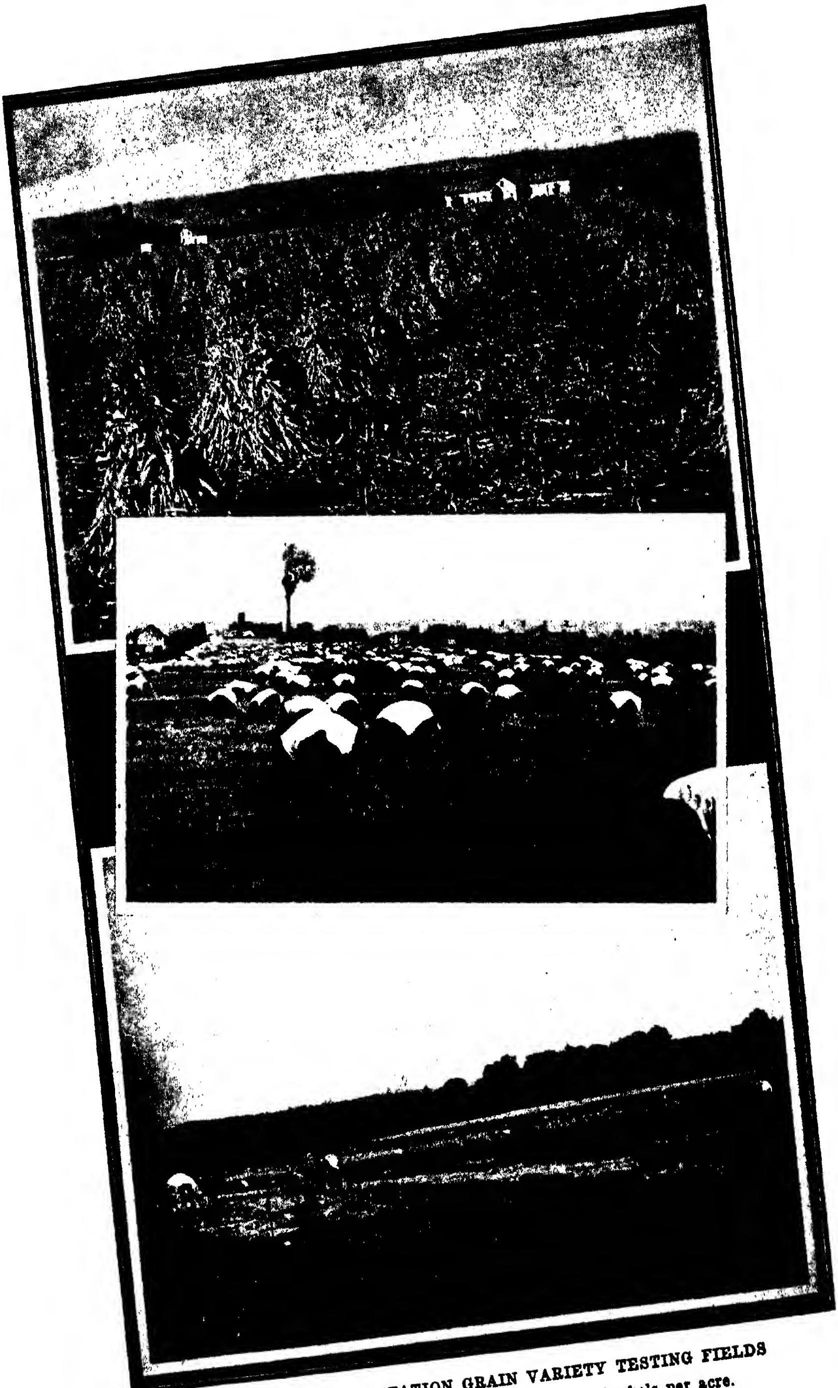

THE EXPERIMENT STATION GRAIN VARIETY TESTING FIELDS

In 1927, 65 varieties of wheat averaged 44.2 bushels per acre.
The Trumbull, used as a check on 21 plots, averaged 45.6 bushels.

HESSIAN FLY IN 1927

J. S. HOUSER

Hessian fly is abundant in northern Ohio this year. The annual wheat field survey was conducted this season as in former years by the Ohio Experiment Station, the State University, and the State Department of Agriculture working cooperatively. A total of 34 counties were surveyed and the results, expressing the average degree of infestation of the wheat for each county, are indicated in the accompanying map.

It is a well established fact, determined thru years of observation, that Hessian-fly damage is periodical in nature. That is, a series of years in which the fly has been comparatively abundant will be followed by a series in which the injury is correspondingly light, and visa versa.

The reason for the fluctuating damage from fly is easily understood. When the insect is relatively scarce, the parasites which are responsible for its destruction find difficulty in locating the insects in which to develop and as a result the fly outstrips these natural enemies and builds up its numbers by leaps and bounds. However, as soon as the fly becomes abundant the parasites have less difficulty in locating it and as a result they too multiply rapidly—more rapidly than the pest. Since several species of these parasites exist, they soon overcome the fly and almost eradicate it, but not entirely. A few of the flies escape their enemies and from this small start, slowly but surely, begin over again the process of building up their numbers. Ultimately, they reach such proportions as again to constitute a scourge. Thus we say for any given year that the hessian fly is on the "increase" or on the "decrease".

It will be clearly evident in the light of the preceding discussion that an average infestation of 30 to 50 percent in June or July may mean two entirely different things so far as probable injury to the next crop is concerned. If the fly is on the "increase", a 30 or 50 percent infestation may mean excessive losses to the next crop unless proper precautions are taken. If the fly is on the "decrease", that is, if the parasites are in the process of gaining ascendency over it, a 30 to 50 percent infestation may mean but very little loss.

The annual wheat field survey tells us from year to year just what the fly is doing. The results of this year's survey, when compared with those of the years just preceding, indicate that the insect is now decidedly on the "increase" and *holds a greater menace to the crop to be sown this fall than it has for several years past,* particularly in northern Ohio.

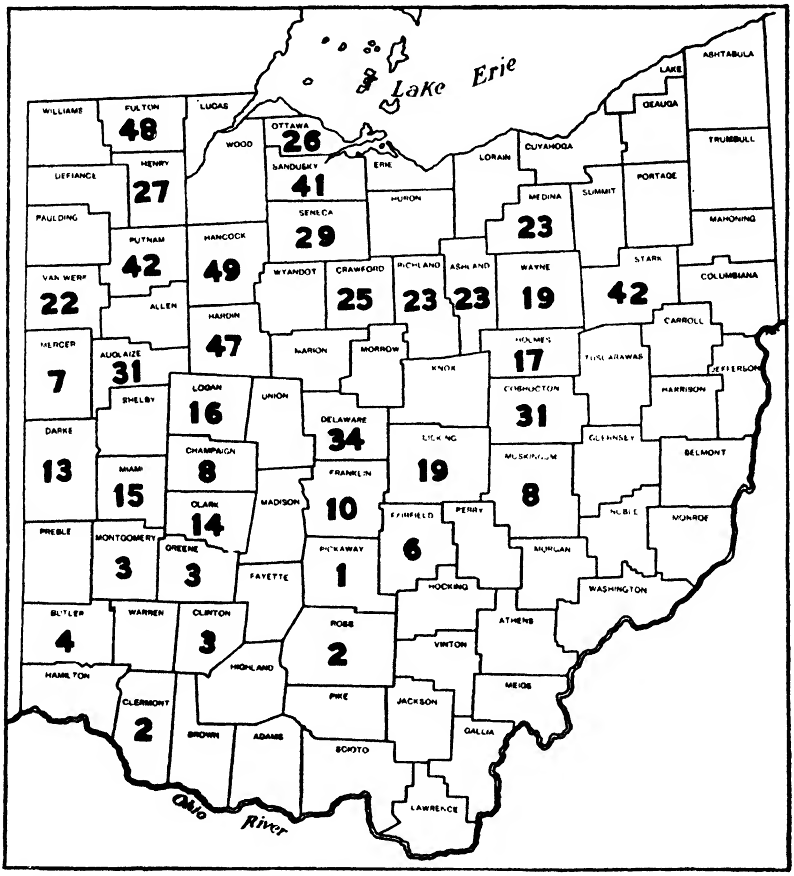

Fig. 1.—Average percentage of straws infested with hessian fly as shown by the wheat field survey of 1927. The numbers indicate the percentage in the counties surveyed

It will be noted also by those who have studied hessian-fly behavior previously that the increase in abundance this season over last has been abnormally rapid. A statement of the reasons for this sudden increase may not be amiss at this time. Undoubtedly some may have difficulty in understanding the situation, particularly when it is remembered that much of the 1927 crop was sown late last fall. When one considers the facts the explanation is very simple.

It will be recalled that last fall clover was in very poor condition. The dry weather in the summer resulted in a very poor stand and when the wheat was cut there were many spots in the field almost entirely bare of clover. Moreover, wet weather at harvest delayed wheat cutting until much of the grain was dead ripe. Consequently the grain shattered and, falling on the bare spots in the field, soon sprouted producing a heavy crop of volunteer wheat, which furnished an ideal breeding place for the fall brood of hessian fly. From this volunteer wheat and from the early sown fields which became infested last fall, a heavy brood of flies emerged this spring. This brood infested the crop and this accounts for the present impending outbreak.

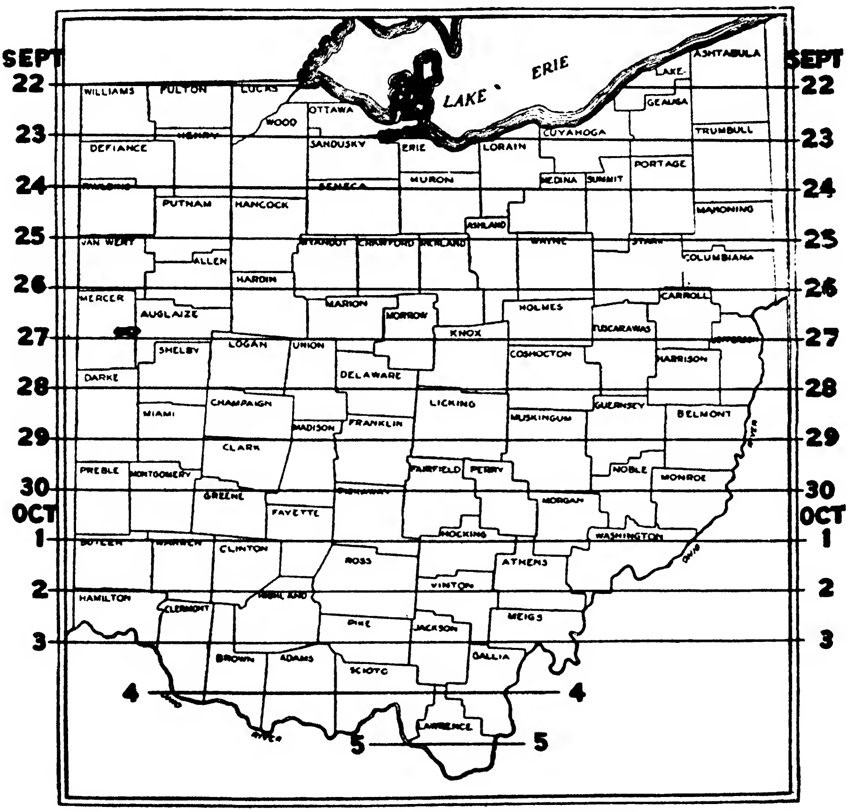

Fig. 2.—Hessian fly-free seeding dates

Farmers may have difficulty in believing the truthfulness of the figures presented, indicating as they do a rather heavy infestation of fly in parts of Ohio in the crop just cut, because there was this year very little external evidence of the presence of the insect.

In other words, there was very little breaking down of straw. The failure of the straw to break down is easily accounted for by the fact that the spring growing season was an exceptionally favorable one for wheat production and the plants stood up well even in the presence of a considerable amount of fly. It is reasonable to assume also that a little more fertilizer was used on wheat last fall than is customary. Many farmers decided that because of the delay caused by fall rains additional fertilizer would be a good investment and this too contributed in minimizing the damage wrought by the fly. With the menace of fly this fall the liberal use of fertilizer is highly recommended.

As seeding time approaches this fall the difficulties encountered last year because of rains will be recalled by farmers. Some may consider disregarding the suggested seeding dates this year provided cultural conditions are favorable preceding these dates. To sow wheat early this fall, particularly in northern Ohio, will be highly hazardous. Fortunately, as has been stated many times before, the so-called "fly free" dates correspond quite closely to the dates for sowing wheat which the Experiment Station has found over a long series of years to give the best yields. Thus we have an added argument against early seeding. Volunteer wheat will not be the problem this year as last since the condition of the young clover is reported as unusually good, and the harvest this year was timely and far less grain shattered than last.

It is earnestly recommended that the suggested dates be adhered to.

STORAGE OF SEED POTATOES

JOHN BUSHNELL

The importance of good seed in successful potato production has been repeatedly demonstrated. In recent years the production of good seed has been fostered by state certification, and the requirements have dealt chiefly with the elimination of inferior varieties and the control of tuber-borne diseases. In the states to the north, which produce the bulk of the certified seed, no special emphasis is placed upon storage requirements. But in Ohio, with its warmer climate, the problems of holding seed with a minimum of

shrinkage, particularly during the spring, are more serious. These difficulties are not confined to home-grown potatoes stored thruout the winter, but apply as well to spring shipments from the north.

A study has been carried on during the last four years to determine the best methods of storing seed potatoes under farm conditions in Ohio. Seed potatoes from the same source were stored in an unheated barn basement, an outdoor pit, a commercial cold storage, and under a number of special conditions. Russet Rural, the dominant variety of northern Ohio, was used almost exclusively in these experiments.

Storage temperature.—In studying the storage of potatoes it must be remembered that for two months or more after harvest, potatoes are in a true dormant stage. During this resting stage they will not sprout even if planted in a greenhouse. Hence, in practical storage there is seldom any difficulty in keeping potatoes during the fall. If they are infected with rots, special precautions must be taken at all times; but as rotting potatoes are rarely stored for seed, the control of rots need not be considered.

During the resting stage, potatoes remain dormant and firm at any ordinary storage temperature. But after the termination of this stage, the temperature must be held below 41° F. to prevent sprouting. The date of the end of the rest is thus of practical importance. By making fall plantings in the greenhouse and watching carefully for the first appearance of sprouts, it was found that the rest period of Russet Rurals from northern Michigan ended December 15, 1924; December 5, 1925; and December 17, 1926. The same variety grown at Wooster remained in a resting stage nearly a month longer, sprouting first in early January.

In December or January, then, the storage temperature must be cooled to 41° F. or lower, to prevent sprouting. The temperature at which the minimum shrinkage occurs as shown by physiological investigators elsewhere is near 38° F. These studies lead to the view that a temperature 2 or 3 degrees below the sprouting point, would be more satisfactory for seed potatoes than a temperature nearer freezing. With this in mind, the cellar storage was held as near 38° as possible by means of ventilation and the occasional use of a small portable kerosene heater. The potatoes from this cellar were planted in comparison with those stored in a commercial cold storage held near 33° F. The cellar stored seed germinated more rapidly and it consistently outyielded the cold storage seed.

There are practical difficulties in cooling a bulk storage to a uniform temperature of 38° F. The tubers themselves generate a small amount of heat. Deep in a pile, the temperature may be 3 to 5 degrees higher than at the surface. Consequently in practical storage, if the air temperature is at 38° F. the tubers in the interior may be above the sprouting temperature. To prevent sprouting, therefore, it is advisable to have the air temperature average about 36° rather than higher.

Effect of Storage Temperature on Yield

Yield in bushels per acre for different dates of planting

	April 20 1926	May 11 1925	May 6 1924	June 18 1923*	Average
Cellar storage, 36°–38° F...	222	221	242	239	231
Cold storage, 32°–33° F....	202	198	212	187	200

*The 1923 cellar-stored seed greened for a month prior to planting.

To cool a well filled storage cellar in Ohio to 36° F. before the end of the resting stage requires special care in ventilating during November and December, opening the doors or ventilators during cool periods and closing them tightly on warm days. This introduces some danger from unexpected frosts; but the warmth of the potatoes, and the fact that they endure a temperature of 29° F. or lower without freezing, precludes injury if a reasonable amount of attention is given to the ventilation. Sprouting in storage during December and January is common in Ohio, while fall freezing in storage is rare.

Similar attention to ventilation may be advisable in the spring to keep the temperature down and thus retard sprouting. If the potatoes are to be planted in April for an early crop, there is no difficulty in holding seed in excellent condition up to the time of planting, but if they are not planted until late May or June, they may sprout excessively in storage unless some precautions are taken. By ventilating on cool spring nights, the temperature in the Station barn basement did not go above 50° F. until late May, with the result that sprouts were less than two inches long when the main crop was planted in late May. This seed consistently produced good yields of potatoes.

Greening.—If the storage cannot be kept cool, or if seed potatoes are purchased in the spring and no cool storage is available, it has long been recommended that the potatoes be spread in a light place rather than held in a warm dark storage. In the light, the tubers become dark and tough, and the sprouts short and green,

adhering to the seed pieces during cutting and planting. The advantage of storage in the light rather than in dark, warm storage is illustrated by a yield of 204 bushels per acre from greened seed planted June 1, 1926 compared with 167 bushels from dark storage seed.

Results such as this have led to the view that greening may always be advantageous, and to the suggestion that all seed should be greened for two weeks or more prior to planting. This suggestion is strengthened by the observation that the sprouts from greened seed appear above the ground several days earlier than the sprouts from seed taken directly from a dark storage. Actual experiments, however, do not support this practice. Greening is better than warm dark storage, but it is not consistently better than cool storage. The actual yields from a sample taken from storage in April and greened for two or three weeks, and from seed directly from storage are given in the table on page 146.

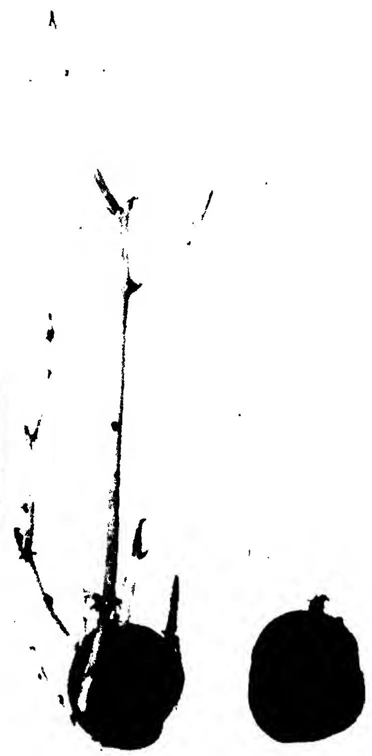

Fig. 1.—Greened seed is superior to seed that has sprouted excessively in storage. Greening is of most value for late plantings

In one season out of four the greened seed planted early in May outyielded that taken directly from a cool cellar storage. The differences from year to year shown in this table are in part due to the conditions in the cellar storage. A cool storage in which the tubers remain firm with but little sprouting appears to be better than greening, but the warmer the storage, the greater the wilting and sprouting, and the greater the advantage from greening.

Greening is therefore to be recommended where planting is delayed until June, and where seed potatoes are purchased in the spring. Spring shipments of certified seed are usually received a week or more before it is possible to plant. Several instances have been reported of poor stands following the temporary storage of

certified seed in a warm shed. Spring shipments should either be moved at once to a cool storage or spread in a thin layer in a light place to green.

Yield From Greened Seed Compared With Seed Directly From Storage

Year	Variety	Planted	Greened	Not greened
1923	Irish Cobbler	May 4	177	186
1924	Russet Rural	May 6	220	242
1925	Russet Rural	May 11	251	221
1926	Russet Rural	May 4	180	180

Ventilation.—Aside from the control of temperature, ventilation is seldom needed for potatoes. The moisture which is given off immediately after they are dug, a process called sweating, is most easily handled by allowing the tubers to dry in the field before moving them to storage. Exposure to light, accompanied by greening and the development of a bitter flavor, is not detrimental to seed stock as it is to potatoes that are to be eaten. Therefore, drying well in the field, or in a temporary storage, avoids the excessive condensation of moisture which is so common and almost unavoidable in the storage of table stock. The moisture itself is not detrimental to the value of seed during the fall and winter, but wet potatoes favor the growth of rots and are disagreeable to handle. When sprouting starts in the spring there is a further disadvantage, for sprouts and their roots grow more rapidly in high humidity than in dry storage. Drying potatoes prior to storage is easier than drying a damp storage.

Fig. 2.—Sprouts develop more rapidly in damp storage than in dry storage

The oxygen requirements of potatoes during storage is so small that no special ventilation is needed during the long period that the

temperature is held below 50° F. With oxygen completely cut off, as in a sealed container, potatoes sooner or later asphyxiate. The characteristic symptom of asphyxiation, or smothering, is an internal blackening, similar to that produced by freezing, called blackheart. Even in deep bulk storage, however, blackheart seldom appears. Apparently the circulation thru a pile 5 or 6 feet deep is adequate to supply the small amount of oxygen needed during the dormant period.

The time of most danger from asphyxiation is when the temperature rises in the spring. In an experiment with potatoes stored in metal cans, with only a hole about 1/16 inch in diameter for ventilation, seed potatoes kept in excellent condition until the middle of May in the cellar storage. These potatoes planted in the field yielded as well as those stored in well aerated crates. On the other hand, in similar cans held until June, at which time the storage temperature had reached 60° F., the sprouts were covered with small swellings, a typical symptom of oxygen deficiency, and some of the tubers were injured by blackheart. Plantings from these cans gave, as expected, poor stands.

Fig. 3.—Symptoms of lack of oxygen: roughening of the surface of the sprouts, followed by death of the growing tip

The conclusion from these observations is that no attention need be given to supplying fresh air to stored potatoes as long as the temperature is held below 50°, or perhaps 55° F. At a temperature above 50° F. sprout growth is rapid, therefore the best procedure is to move the potatoes out to green. This will both retard sprout growth and insure an adequate supply of oxygen.

Precautions in pitting potatoes.—Storage in the field by covering piles of potatoes with alternate layers of straw and dirt is called pitting. The temperature in a pit may easily be watched by having a slender thermometer attached to string in a tube, preferably a wooden tube, extending to the center of the pit. In pit storage the same precautions are to be observed as in cellar storage:

(1) The temperature must be below 41° F. by the end of the resting stage to prevent sprouting. This is accomplished by cover-

ing lightly with but one layer of straw and dirt until this temperature is reached.

(2) Best results are to be expected if the temperature during the winter is near 38° F. Thick layers of straw and dirt are applied as soon as the temperature reaches this point.

(3) No provision for ventilation is necessary until the temperature rises to about 50° F. in the spring, when the pit should be opened. If cool weather prevails after this, a light layer of straw will admit sufficient air and at the same time serve as a protection from spring frosts. When the weather becomes hot the safe procedure is to spread the potatoes out to green.

FATTENING WESTERN LAMBS IN THE CORNFIELD—CORNFIELD AND DRY-LOT FEEDING COMPARED

D. S. BELL AND L. E. THATCHER

Experiments in lambing-down standing corn were conducted by the Ohio Experiment Station in the fall of 1925 and 1926. The purpose of these experiments was to determine whether lambs can successfully harvest standing corn, and if so, what additional feed or intercrop forage would insure the greatest return. The experiment was planned so as to permit a comparison of cornfield feeding with dry-lot feeding.

In these tests seven lots of "good to choice" blackfaced western feeding lambs were turned into the cornfield and, with the exception of one lot, were allowed various feeds in addition to standing corn. Each year a similar lot of lambs was fed in the shed to permit a comparison of dry-lot feeding with cornfield feeding.

Table 1 shows that lambs successfully harvested standing corn when an additional feed, or a combination of feeds, was provided to fortify the ration of standing corn alone. When the ration of standing corn was *not* thus fortified by supplementary feeding the rate of gain was slow, the cost of gain was prohibitively high, and the return made by the lambs for an acre of 60-bushel corn was, in comparison, very small.

Of all the various additions to the standing corn, the combination of .8 lb. of legume hay and .14 lb. of linseed oil cake daily per lamb proved the best. When these additions were fed as separate

TABLE 1.—Fattening Western Lambs in the Cornfield—Cornfield and Dry-lot Feeding Compared

Average of two trials—1925 and 1926

Ration fed to each lot	Lot 1 Cornfield alone	Lot 2 Cornfield. .25 lb. linseed oil cake	Lot 3 Cornfield. hay	Lot 4 Cornfield. 15 lb. linseed oil cake, hay	Lot 5 Cornfield, rape (oil cake and hay after rape was eaten†)	Lot 6 Cornfield. soybeans (oil cake and hay after soybeans were eaten†)	Lot 7 Cornfield. bluegrass	Lot 8 Dry-lot Shelled corn, .15 lb. linseed oil cake, hay
Total number of lambs fed	47	47	47	47	47	47	47	47
Total number of lambs dying	1	2	3	1	0	2	0	2
Average initial weight, pounds	60.01	60.01	59.93	59.50	59.38	60.48	60.67	60.92
Average final weight, pounds	70.71	80	83.24	85.76	81.51	81.58	76.72	84.33
Average daily gain, pound	.151	.266	.299	.353	.335	.286	.210	.323
Average length of feeding period, days	69.5	73	73	73	66	73	76.5	69.5
Average ration, pound								
Shelled corn (15.5 % moisture)	1.54	1.54	1.39	1.50	1.58	1.24	1.23	1.25
Linseed oil cake (pea size)	....	.23	....	.143	.09	.12	....	.144
Legume hay	....	....	.895	.821	.57	.736	....	1.072
Feed required for 100 pounds gain, pounds								
Shelled corn	1,020.8	578.1	464.6	424.6	471.4	434.2	584.0	388.1
Linseed oil cake	....	86.02	....	40.50	27.88	41.03	....	44.59
Legume hay	39.5‡	26.48‡	299.0	232.8	169.8	257.2	30.8‡	332.1
Cost of 100 pounds gain	$12.00	$ 9.13	$ 8.29	$ 8.24	$ 7.81	$ 8.61	$ 9.36	$ 8 93 (9.51)*
Average initial cost of lambs per 100 lb.	$16.33	$16.33	$16.33	$16.33	$16.33	$16.33	$16.33	$16.33
Average final value of lambs per 100 lb.	$13.00	$13.88	$14.13	$14.13	$13.88	$13.88	$13.50	$14.25
Return per acre (60 bu. shelled corn basis§)	$39.41	$62.22	$76.01	$79.90	$74.76	$65.31	$58.53	$78.93 (74.13)*

*This figure was obtained when 8 cents per bushel was allowed to cover the cost of harvesting, storing, and feeding the shelled corn to the lambs of Lot 8.

†Hay according to appetite together with .15 lb. of linseed oil cake daily per head was fed to lambs in Lots 5 and 6 after the inter-crop forage was consumed. In the 1925 test the rape lasted four weeks and in 1926 three weeks. The soybeans lasted two weeks in each test.

‡In Lots 1, 2, and 7 hay appears in the item "Feed required for 100 pounds gain" when no hay is indicated in the ration fed. This is because all lambs were fed hay during the first few days in the cornfield to avoid, if possible, digestive disorders.

§In computing the "Return per acre", which was adjusted to a 60-bushel basis, the total gain per lot was valued at the final market price per 100 pounds. The initial cost of the lambs was disregarded. The cost of the additional feed was thus deducted from the value of the gain produced in the respective lots and the assumption made, based on average reductions, that the rape in Plot 5 reduced the yield of corn 3% and the soybeans in Plot 6 reduced it 12%. No values were assigned to the inter-crop forages in Lots 5 and 6, but in the "Return per acre" these forages show their effect.

The yield of corn in each plot was determined and this yield computed to a 15.5% moisture basis. In 1925, 23 lambs and in 1926 24 lambs constituted a lot. In both experiments each plot contained three-fourths acre.

Fig. 1.—Lambs make use not only of the corn grain but the leaves and under growth as well. During the early part of the corn-field period rape provides the necessary fortification to the ration of standing corn alone

Fig. 2.—When the inter-crop forage is done and frost has caused the leaves and husks to be dry and unpalatable it is necessary for best results to add legume hay and linseed oil cake to the ration of standing corn

supplements to the standing corn, .9 lb. of legume hay effected a greater improvement in the rate of gain, a greater reduction in the cost of 100 pounds gain, and caused a greater return per acre of 60-bu. corn than did .23 lb. linseed oil cake daily per lamb. Either feed alone as a supplement was responsible for a decided improvement over the ration of standing corn alone.

Of the two inter-crop forages, rape proved superior to soybeans in withstanding foraging and trampling, in causing the lambs to gain rapidly and economically, and in effecting a material saving in the amount of hay and linseed oil cake required for each 100 pounds gain. During years when very high prices prevail for hay and linseed oil cake, rape should prove its worth in a more pronounced fashion than in these tests.

The return per acre, the rate of gain, and the cost of 100 pounds gain made by the lambs allowed bluegrass and standing corn were not entirely satisfactory. The tendency on the part of the lambs to grow rather than to fatten was pronounced, and the lack of finish which they showed at the close caused them to be assigned the next-to-lowest final value.

In comparing the dry-lot lambs with the best lot of cornfield-fed lambs—those receiving hay and linseed oil cake in addition to the standing corn—the latter made .03 lb. greater average daily gain per lamb, 100 pounds gain at 69 cents less cost, and 97 cents more for 60 bushels of corn consumed. If we assume that it cost 8 cents per bushel to harvest, store, and feed the corn to the dry-lot lambs, then three lots of cornfield-fed lambs made cheaper gains and showed a greater return per acre of 60-bushel standing corn than the shed-fed or dry-lot group.

These three best systems of lambing-down standing corn consisted of supplementing it with (1) hay and linseed oil cake; (2) hay alone; (3) and rape as an intercrop followed by hay and linseed oil cake after the rape was consumed.

IS A LAMB BORN OR MADE A CULL?

D. S. BELL

Each year many extremely thin and undersized native lambs appear at eastern stock yards. They are classed as cull or "skip" lambs and sell for a very low price— a price sufficiently high, however, considering their meat-value. With a desire to ascertain whether it is the lamb's individuality or gross neglect that causes it to fall into this class, the Ohio Experiment Station secured 19 "skip" lambs at the Cleveland stock yards on December 13, 1926. The actual appearance of these lambs is hard to picture in words. They were an extremely thin, pale-skinned, shaggy-wooled, listless bunch of lambs averaging in weight 52 pounds. They cost $7.00 per 100 pounds at the stock yards, when $14.50 was the ruling top for fat lambs.

These lambs were delivered by truck to the Station feed lots and were started on a ration of oats 2 parts and wheat bran 1 part together with all the good quality legume hay they cared to eat. Between December 13 and January 26 they were allowed all of these feeds they would consume. They were treated four times for stomach worms, using copper-sulfate solution, and dipped once for ticks. During this preliminary period they gained but .15 lb. daily, and each 100 pounds gain cost $19.28.

On January 26 the lambs were started on the fattening ration of a full feed of shelled corn and alfalfa hay, together with .15 lb. linseed oil cake daily per lamb. During the 98-day feeding period which followed, the lambs gained at the rate of .332 lb. daily and this gain cost $7.91 per cwt. The feed required to produce each 100 lb. gain was only slightly greater than that required by good to choice mutton feeding lambs. At the close of the feeding period the lambs were appraised at $16.25 per cwt. by a market expert from the Pittsburgh stock yards. This value was 25 cents above the quoted top on that market of $16.00 for fat lambs. Crediting the lambs with the wool sheared, 5.14 lb. each, at 40 cents per pound, the return over feed cost was $7.11 on each lamb, or $135.00 for the 19 lambs.

Neglect on the part of the producer, rather than any inherent quality due to their breeding, was responsible for these lambs' being classed in December as culls and thus bringing only $7.00 per 100 pounds.

COTTONSEED MEAL POISONOUS TO PIGS

G. BOHSTEDT, R. M. BETHKE, AND B. H. EDGINGTON

Cottonseed meal has sold so much cheaper all season in comparison with linseed meal that many farmers have preferred it in rations of various classes of livestock. With tankage also selling relatively high, cottonseed meal has been fed to pigs this year perhaps more than at any time previously. Most feeders are aware of the fact that under certain conditions cottonseed meal may poison pigs. When not too much of it is fed, pigs do not seem to be bothered.

Recently at different experiment stations cottonseed meal has been fed half and half with tankage, both in dry-lot and on pasture, with good results. The mixture made an efficient protein supplement, which proved more economical under price conditions than tankage alone. An experiment just finished at the Ohio Experiment Station, where cottonseed meal and tankage are fed in combination, corroborates those findings.

It should not be forgotten, however, that, where a high proportion of cottonseed meal is fed in pig rations, bad effects may be expected. An experiment was conducted during the fall of 1926 at this Station to study the proteins of cottonseed meal and linseed meal. Several classes of animals, including pigs, were used. The problem of the toxicity of cottonseed meal for pigs was rather incidental to the immediate problem. However, the data secured constitute further proof of the harmful effect of cottonseed meal when fed in large amounts, or when used to balance a grain ration for pigs. From 20.2 to 25 percent of cottonseed meal was fed. The rest of the mixture was composed of yellow corn and 2 percent minerals. The minerals consisted of the following mixture: 40 pounds pulverized limestone, 40 pounds special steamed bone meal, and 20 pounds salt. The pigs were self-fed, and kept in concrete-paved pens inside of the Station hog barn.

The pigs of Lot 1, fed corn, oilmeal, and minerals made fair gains under dry-lot conditions, and not exposed to sunlight in the open (Table 1). The protein of this ration, as of the other two rations, was rather deficient. The pigs fed cottonseed meal lagged behind in gains from the start. One of the pigs in Lot 2, which was fed a ration having the same nutritive ratio as the ration of Lot 1, died after 153 days on experiment. A pig in Lot 3, which was fed 25 percent cottonseed meal, died after only 67 days.

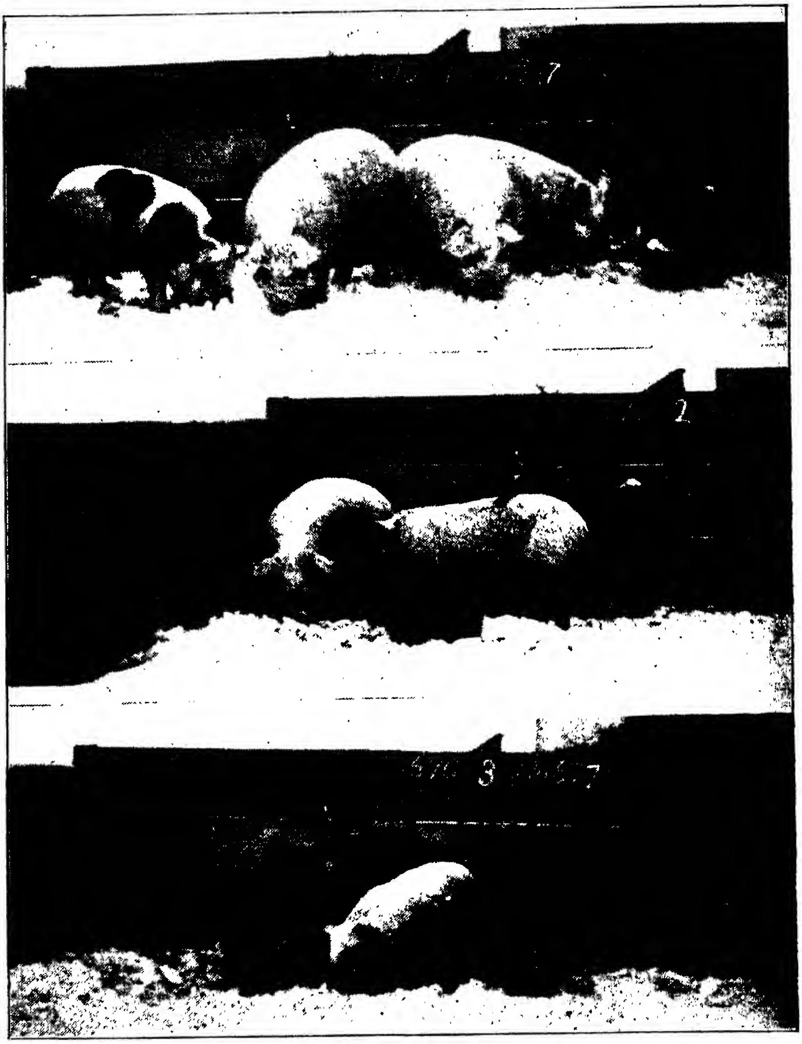

Fig. 1.—Cottonseed meal proved poisonous for pigs

Top picture—Linseed meal (one-fourth of ration) with corn and minerals.—The pigs were fairly thrifty from start to finish.

Middle picture—Cottonseed meal (one-fifth of ration) with corn and minerals.—The ration plainly disagreed with the pigs. One had already died. The one on the floor suffered with convulsions.

Bottom picture—Cottonseed meal (one-fourth of ration) with corn and minerals.—The more cottonseed meal was fed the worse the result. Two pigs had died. The rest were not thrifty.

Another pig on the same ration succumbed to the very evident toxicity of the cottonseed meal after 78 days. These cottonseed meal-fed pigs had a rough and wrinkly appearance for some time before they died, or were slaughtered. Some of them were asthmatic. One pig in Lot 3 was wont to go into comvulsions when disturbed by an attendant. Autopsies of the pigs that had died showed rather typical hemorrhages of intestinal mucosa with interlobular infiltration of the lungs associated with poisoning. The remaining pigs made very uneconomical gains. The amounts of cottonseed meal fed to these pigs were no doubt larger than most farmers would feed.

TABLE 1.—Cottonseed Meal vs. Linseed Meal for Pigs in Dry-lot

Lots 1 and 2 were fed the same proportion of digestible protein in the mixture

Five pigs per lot, self-fed, in barn from August 26, 1926, to January 5, 1927—132 days	Lot 1 Corn 73% Oilmeal 25% Minerals 2%	Lot 2 Corn 77.8% Cottonseed meal 20.2% Minerals 2 %	Lot 3 Corn 73% Cottonseed meal 25% Minerals 2%
Average weight at start, lb.	31.7	32.0	31.5
Average weight at end, lb.	139.7	105.8*	107.2*
Average daily gain, lb.	.82	.46	.52
Average daily feed, lb.	3.06	2.32	2.26
Feed required for 100 lb. gain, lb.	374	504	439

*One pig died in Lot 2, and 2 in Lot 3 before the end of the 132-day period.

On the morning after slaughter it was observed that the carcasses of the cottonseed meal-fed pigs were extremely yellow, both the internal fat and the outside of the hide.

Summary.—Cottonseed meal has given good results when fed in combination with tankage, with tankage and pasture, or tankage and alfalfa meal, supplementing corn for pigs.

When used as the only protein feed in balanced rations with yellow corn, even tho good minerals were fed in addition, cottonseed meal proved poisonous to pigs.

IMPROVING A CORN AND TANKAGE RATION FOR PIGS IN DRY LOT

W. L. ROBISON

Few feeds surpass tankage as a single supplement to corn, and yet pigs often fail to thrive on merely corn and tankage, especially if they are farrowed rather late in the fall and do not get a good start on grass before they are placed in winter quarters. Feeding investigations at this and other experiment stations have demonstrated various ways of improving a corn and tankage ration for dry lot feeding.

With the few exceptions noted later, the pigs used in the experiments herein reported were confined thruout the tests in 10 by 12-foot pens of a central house having concrete floor, and equipped with wooden in-lays for beds. Their average weights ranged from 40 to 59 pounds at the beginning of the tests. In some of the experiments the rations were hand-fed. In the others they were self-fed. When self feeding was practiced the feeds were mixed and fed in definite proportions rather than placed in separate compartments of the feeders and self-fed free-choice. Since pigs as they become older need a smaller proportion of protein in the ration, the proportion of corn was increased and the supplement reduced, when an average weight of 100 to 125 pounds was reached.

Alfalfa meal helpful.—Two trials were conducted in which alfalfa meal was fed with corn and tankage, at the rate of 3 percent of the total ration. The pigs were hand-fed and were carried to approximately the same average final weight rather than for a given length of time. Those given corn and tankage gained .93 pound daily a head and ate 370 pounds of corn and 35 pounds of tankage, or a total of 405 pounds of feed for each 100 pounds of gain. Those given corn, tankage, and alfalfa gained 1.01 pounds daily and ate 357 pounds of corn, 31 pounds of tankage, and 12 pounds of alfalfa, or a total of 400 pounds of feed for each 100 pounds of gain.

Linseed meal and alfalfa meal combined were more effective than alfalfa alone for feeding with corn and tankage. This mixture was first tried by the Wisconsin Station. It has since been used at a number of stations, and has usually given excellent results, especially when the pigs were started on the experiment shortly

after weaning time. Table 1 contains a summary of three experiments in which a ration of corn, tankage, linseed meal, and alfalfa was compared with one of corn and tankage.

Including linseed meal and alfalfa meal in the ration resulted in increasing the rate of gain .31 pound daily a head, and enabled the pigs to reach an average weight of 200 pounds 47 days earlier than those getting only corn and tankage. The linseed meal also brought about a saving of 19.7 pounds of feed for every 100 pounds of gain produced. Taking into account only the corn and tankage saved, with these valued at 84 cents a bushel and $75 a ton, respectively, the mixture of linseed meal and alfalfa meal was worth $71.80 a ton, or 95.7 percent as much as the tankage. This value, of course depends on the relative prices of corn and tankage. The proportions of linsed meal and alfalfa meal fed amounted to practically one pound of each to every two pounds of tankage.

In one experiment, bright green, leafy alfalfa hay kept before the pigs in a rack was compared with alfalfa meal, mixed with the other feeds. The pigs ate the hay readily, particularly during the early part of the test, when it was most needed, and gained 1.32 pounds daily a head, as compared with a gain of 1.21 pounds made by those getting the meal. There was practically no difference in the feed required per unit of gain except that the hay eaten was practically double the quantity of alfalfa meal fed. Since the hay was less expensive than the meal the feed cost per 100 pounds of gain was the same for the two lots. Whether sufficient hay would always be consumed, especially if its quality was not of the best, may be questioned. By grinding the hay and mixing it with other feeds the pigs can be forced to take the desired amount.

Clover is grown on many farms which have no alfalfa. To determine whether leafy clover could be substituted for alfalfa, chopped second-growth clover of good quality was compared with chopped alfalfa of similar character. There was practically no difference in the response of the two groups of pigs. Probably alfalfa is usually of a little better quality than clover, but apparently clover is as efficient as alfalfa if it is of equal quality.

Ground limestone added to corn and tankage proved beneficial in dry-lot feeding. Table 1 gives the average results of three experiments in which corn, tankage, and salt were compared with the same ration plus limestone. Limestone similar to that applied to the soil but more finely ground or else having the coarser particles sifted out was fed. In two cases it constituted 1.5 percent and in the other 1 percent of the total ration. The smaller quantity apparently was sufficient.

TABLE 1.—Effect of Adding (1) Limestone and (2) Linseed Meal and Alfalfa Meal to Corn, Tankage, and Salt

For Pigs in Dry Lot

	Corn Tankage Salt	Corn Tankage Salt and **Limestone**	Corn Tankage **Linseed meal*** **Alfalfa meal** Salt
Number of experiments	3	3	3
Number of pigs	23	22	23
Initial weight per pig	48.8	49.3	48.7
Average daily gain	**.86**	**.96**	**1.17**
Daily feed per pig:			
Corn	3.15	3.44	3.90
Supplement	.33	.35	.62
Minerals†	.01	.06	.02
Total	**3.49**	**3.85**	**4.54**
Feed per 100 pounds gain:			
Corn	367.92	356.26	333.16
Supplement	38.02	35.87	53.01
Minerals†	1.31	6.61	1.37
Total	**407.25**	**398.74**	**387.54**
Cost of feed per 100 lb. gain‡	$6.98	$6.72	$6.55

*Proportions were approximately tankage 2, linseed meal 1, alfalfa meal 1.

†Consisted of salt only in the first and third lots and of salt and limestone in the second lot.

‡Corn 84¢ a bu., tankage $75, linseed meal $50, alfalfa meal $30, salt $20, and limestone $8 a ton.

TABLE 2.—Skimmilk as a Partial Substitute for Tankage (Part 1); and Effect of Rice Polish in Corn, Tankage, Salt, and Limestone Ration (Part 2)

For Pigs in Dry Lot

	Part 1		Part 2	
	Corn Tankage Salt Limestone	Corn Tankage **Skimmilk** Salt Limestone	Corn Tankage Salt Limestone	Corn Tankage **Rice polish** Salt Limestone
Number of trials	3	3	3	3
Number of pigs	23	24	20	20
Initial weight per pig	45.2	44.8	44.7	44.3
Average daily gain	**.99**	**1.23**	**1.02**	**1.18**
Daily feed per pig:				
Corn	3.71	4.00	3.40	3.40
Tankage	.38	.23	.34	.34
Skimmilk	....	3.32	....	....
Rice polish	....	....	....	.40
Salt and limestone†	.07	.07	.06	.06
Total	**4.16**	**4.67***	**3.80**	**4.20**
Feed per 100 pounds gain:				
Corn	376.42	324.81	333.48	288.90
Tankage	38.18	18.37	33.54	29.29
Skimmilk	....	269.59	....	....
Rice polish	....	....	....	34.11
Salt and limestone†	7.01	5.86	5.59	4.78
Total	**421.61**	**378.69***	**372.60**	**357.08**
Cost of feed per 100 lb. gain‡	$7.11	$6.53	$6.29	$6.08

*With the skimmilk reduced to a moisture content of 10 percent.

†In each case a commercial grade of calcium carbonate instead of limestone was used in one of the three trials.

‡Corn 84¢ a bu., tankage $75, salt $20, limestone $8, rice polish $36.60 a ton, skimmilk 35¢ a cwt.

Limestone increased the rapidity of growth .1 pound daily a head and saved 8.5 pounds of feed for every 100 pounds of gain. Each pound of limestone replaced 2.19 pounds of corn and .4 pound of tankage. Feeding limestone in connection with the supplemental mixture of tankage, linseed meal, and alfalfa was tried in one experiment. The pigs receiving it gained .05 pound more daily a head, but made no greater gain from a given amount of feed than those getting the same ration without the limestone.

When fed with corn, salt, and limestone a mixture of 2 parts tankage and 1 of linseed meal produced more rapid gains and greater gains from a given amount of feed than tankage alone, but was less effective than the trio mixture of tankage, linseed meal, and alfalfa. Adding one-half of 1 percent of cod-liver oil to the corn-tankage-linseed meal-salt-limestone ration made it as efficient as adding alfalfa. Because of the expense of the cod-liver oil, however, the gains were more costly.

In two experiments the ration of corn, tankage, linseed meal, salt, and limestone was fed to a second group of pigs which were given the run of a 10 by 12-foot outside pen having a board floor. The pigs allowed to run outside in one test made more rapid and more economical gains than those fed the same but kept indoors. Their performance equalled that of pigs which were kept inside and fed the same ration plus alfalfa meal. The benefit of the outside run was not marked until spring when there was a greater amount of sunshine than there had been during the winter. In the second test the pigs having the outside run did no better than those on the same feed that were confined indoors.

Skimmilk and tankage proved an effective combination. Feeding skimmilk at the average rate of 3⅓ pounds daily a head with about half the usual amount of tankage was tried in three experiments. All lots were given salt. A commercial grade of calcium carbonate was also fed with both rations in one trial and limestone in the others. A summary of the results is given in Table 2.

As determined from the amount of other feed replaced at the prices given in the table, and without taking the more rapid gains into consideration, the skimmilk was worth 56 cents a hundredweight for use as a partial substitute for tankage. As a complete substitute for tankage it is worth approximately 1/10 as much as an equal weight of tankage. With tankage at $75 a ton this would give skimmilk a value of 37½ cents a hundredweight.

Rice polish proved beneficial. This is the by-product of rice milling obtained in polishing the kernels after the hulls and bran

have been removed. It contains approximately 12 percent of protein, and would not class as a high protein feed. It is low in fiber, exceptionally rich in phosphorus and highly nutritious. Inasmuch as it had been found to have a high value for use in rather limited quantities with a ration of corn, linseed meal, and minerals, it was tried with corn and tankage. The last two columns of Table 2 summarize three experiments in which corn, tankage, salt, and limestone, and the same ration containing a little less than 10 percent of rice polish were fed.

The pigs receiving the rich polish reached an average weight of 200 pounds 20 days earlier than those getting the same ration without it. They also required an average of 15.5 pounds less feed for each 100 pounds of gain. If valued at the prices given in the table, the feed replaced by it would give the rice polish a comparative value of $42.91 a ton. Since it is a relatively inexpensive feed at the mills it offers another means of increasing the efficiency of a corn and tankage ration for winter feeding in sections where the freight rate is not prohibitive.

Wheat middlings are often fed with corn and tankage. In 17 tests conducted at a number of stations and including a total of 175 pigs on each ration, those fed corn and tankage and those fed corn, middlings, and tankage gained 1.25 and 1.36 pounds daily a head and consumed 426 and 432 pounds of feed for each 100 pounds of gain, respectively. Perhaps, because middlings produce more rapid gains, they sometimes sell for more than they are worth for feeding with corn and tankage to fattening pigs, if their value be determined by the quantity of other feeds they replace.

Summary.—In conclusion, where skimmilk, or buttermilk, is not available for feeding in limited quantities along with tankage, the trio mixture of tankage, linseed meal, and alfalfa provides an effective general supplement to corn or other grains for pigs in dry-lot. It may be self-fed in one compartment of the feeder and corn in another; mixed with the corn and self-fed; or, perhaps preferably if ear corn is fed, given on a basis of so much daily a head. Increasing with the corn consumption, pigs between 50 and 100 pounds in weight should receive .4 to .5 pound daily a head, and heavier shotes .6 to .8 pound.

PALATABILITY OF POULTRY FEEDS

D. C. KENNARD AND L. B. NETTLETON

The value of a feed stuff or of a feed mixture for chickens depends largely upon how well they like it. Poultry keepers are concerned chiefly in how to get their birds to eat more rather than about over feeding, for profitable production of eggs or meat depend upon heavy feed consumption. The palatability of a ration therefore, is important.

Of the grains, corn and wheat are the most liked, and rye the least liked by chickens. Barley and oats share an intermediate place in this respect. Meat products usually rank high in palatability. Chickens naturally like granular or grain-like material better than the same material finely ground. Dusty feed is disliked.

The fact that whole or cracked grain is more palatable than ground grain or a dry mash presents a troublesome problem in poultry feeding. Because chickens like the grains when fed separately better than the mash, considerable skill in feeding the grain is required if the ration is not to be unbalanced by an excess of grain, since it is the mash that is the balanced part of the ration so far as proteins, minerals, and some vitamins are concerned. Obviously the simple solution of this difficulty is to feed the grains as a part of the mash. Thus the whole ration will be definitely balanced without involving the care and skill required to feed the grain and mash separately.

Many poultry keepers have found in the all-mash method of feeding an effective solution of this problem. However, as it is essential that the mash be composed of granular material as far as possible, the difference in the degree of fineness and palatability of certain parts of the all-mash mixture does not altogether eliminate this difficulty. Any ground mixture is most palatable in a granular form, the granules varying in size from that of pin head oats to a kernel of wheat. A coarse mash may be made by selecting feed stuffs such as coarse ground corn, medium meat scraps, and medium granulated (chick size) poultry bone meal. Even so, the middlings and fine part of the ground corn and meat scraps are last to be eaten. This requires additional attention to the amount to be fed and the time and frequency of feeding the mash in order to encourage greater feed consumption. In practice this is accomplished by feeding the chicks three times a day and the growing

pullets and layers once daily in the evening an amount of mash that will be about consumed before the next feeding. During the winter, when greater feed consumption by the layers is important, the fresh mash may be fed two or three times a day to advantage.

To secure definite information as to how the coarseness or fineness and how different ingredients affect the palatability of a feed mixture, the Ohio Station conducted tests with one group of 100 White Leghorn pullets and another of 80 Barred Rock pullets. Three reel mash feeders each 4 feet long were placed end to end in each pen and located so that all were equally lighted and accessible. The test was conducted for 11 months during which careful records of the consumption of the three different mashes were made. A mixture of coarse-ground yellow corn 65, winter wheat middlings 20, medium meat scraps 10, medium granulated chick-size poultry bone meal 4, and salt 1, was kept in one feeder. Another contained the same mixture with all ingredients finely ground as is the customary practice. A third contained a popular mash mixture composed of ground yellow corn 30, ground wheat 20, ground oats 20, wheat bran 10, winter wheat middlings 10, medium meat scraps 10. The first two are of interest in respect to how the degree of fineness of the same mash mixture affects the palatability. The third shows the effect of ground oats and wheat bran upon the palatability of a mash mixture as compared to corn.

For each 100 pounds of the coarse mash consumed, the Leghorns ate 70.2 pounds of the same mixture ground fine and 47.5 pounds of the mash containing finely ground oats and wheat bran; and for each 100 pounds of the coarse mash, the Plymouth Rocks ate 65.4 pounds of the fine mash and 23.8 pounds of the mash containing finely ground oats and wheat bran. For each total 100 pounds of the two corn mixtures, the Leghorns ate 27.9 and the Plymouth Rocks 14.4 pounds of the third mixture, which contained finely ground oats and wheat bran. These figures are significant and merit careful thought. They serve as a rough index as to how palatability of a mash mixture may be affected by certain of its ingredients or by the relative degree of its fineness. At the same time these results should not be applied too literally or taken too seriously in judging the relative value of mash mixtures. For example, suppose the groups of birds had been fed either of the less palatable mash mixtures only—they then would have consumed about the usual amount to meet their requirements in spite of the difference in palatability. That is to say similar groups of layers each fed a different one of the mash mixtures would not have

yielded differences in egg production at all comparable to the differences in palatability. In fact, tests comparing the coarse corn mash mixture with the mixture of ground oats and wheat bran have failed as yet to prove which is the better of the two.

Nevertheless the relative palatability of feed stuffs or mash mixtures is an important factor and deserves careful consideration. The advantage of a granular mash mixture over a finely ground mixture is evident. Undoubtedly this will be recognized and put into practice by those who mix their own feed as well as by commercial feed manufacturers. Already many progressive poultry keepers are using the coarse in preference to the finely ground mash. The granulated mash has the same advantages over the finely ground product, whether it is to be used in connection with scratch grain or for all-mash feeding.

A balanced ration in granular form is a development to be expected in connection with all-mash feeding. Such a mash may consist of granules about the size of a wheat kernel free from fine material. Each granule would comprise all the parts of the finely ground material we are obliged to use at present. Granulation would greatly improve the palatability of the mash and would mark a real advance in modern poultry feeding. The development of the process for granulation is essentially a feed manufacturer's problem. The logical procedure would be to develop the process in the laboratory and then design the necessary machinery. The process will likely require a combination of moisture, heat, and pressure, and possibly the use of a binder, such as molasses. This is to be expected in the near future; who will be the first to accomplish it?

VARIATIONS IN YIELD OF HOGS SLAUGHTERED AT FEDERAL INSPECTED PACKING PLANTS

GEO. F. HENNING

Only within recent years have farmers become interested in the yield of their hogs. Most farmers were only interested in getting their hogs sold, after which they had little interest in the hog and what the packer did with the dressed product. With many this is still true. However, a change, started within the last few years, is taking place.

With the coming of cooperatives into the field several marketing practices have been modified. Probably one of the outstanding changes that is being introduced gradually into livestock marketing by the cooperatives is the practice of selling hogs on a dressing percentage.

Yield of Hogs Slaughtered at Federal Inspected Packing Plants, 1923-1927, inclusive

Month	1923	1924	1925	1926	1927	1923-1926 4-yr. average
January	77.7	76.4	75.2	76.8	78.1	76.5
February	78.1	76.6	74.6	77.1	77.4	76.6
March	77.7	76.1	76.0	76.6	77.1	76.6
April	77.1	76.0	76.3	76.9	77.2	76.6
May	76.4	75.4	76.6	76.5	....	76.2
June	76.7	75.4	75.7	76.9	....	76.2
July	76.3	75.3	75.6	76.6	....	75.9
August	76.7	75.0	76.2	77.1	....	76.2
September	75.3	74.5	74.6	76.3	....	75.2
October	75.2	73.1	74.4	75.2	....	74.9
November	76.1	73.8	75.3	74.5	....	74.9
December	76.2	76.2	76.3	75.9	....	76.1
Average	76.62	75.31	75.56	76.36	....	....

Source: Crops and Markets published by U. S. Department of Agriculture.

The packer is primarily interested in the dressed product. It is the carcass of the animal that he sells to the retailer, who in turn furnishes the consumer meat from day to day. It makes considerable difference to the packer when he buys hogs, for example, whether an animal dresses 76% or 80%. Stated in another way a 200-pound hog that dresses 80% will yield a carcass weighing 160 pounds, while one dressing 76% will yield 152 pounds, a difference of 8 pounds in dressed weight in favor of the 80-percent hog.

In almost all instances the same weight hog yielding the higher dressing percentage is more valuable to the packer. Assuming that the packer pays $10.00 per hundredweight for the two hogs, each will cost him $20.00, but the one yielding 80% will cost on a dressed weight basis $20 divided by 160, or 12½ cents per pound; the other, $20.00 divided by 152, or 13.15 cents per pound. Clearly the higher dressing hogs are more valuable on foot than low dressing hogs.

Some packers thru purchases from cooperatives are reflecting the differences in yields, and the cooperatives in turn are reflecting the varying yields back to the livestock producers. When this occurs the livestock producer immediately becomes interested in dressing percentages and in producing hogs that will make a high yield. He, too, wishes to know yields from month to month and year to year. The livestock producer then wishes to know how the average hog dresses and what are seasonal and year-to-year variations. Table 1 presents the average yield by months since January 1, 1923.

The dressing percentages given in Table 1 are on hogs slaughtered at Federal inspected packing plants in the United States as reported to the U. S. Department of Agriculture. A high point of 78.1 percent was reached in February 1923, and then followed a gradual decline with a few interruptions until the low point of 73.1 percent was reached in October, 1924, which was followed by an abrupt rise to 76.2% in December of the same year. For the next several months the yield was rather irregular but made a seasonal low in October, 1925 of 74%, which was followed by a February high of 77.1%. For the next six months the yield did not vary more than six-tenths of 1%. This was very different from the springs and early summers of 1923, 1924, and 1925. Then the dressing percentages fell rapidly, making a seasonal low in November 1926 of 74.5%. This low point was followed by a rapid climb to a high in January 1927, when the yield reached 78.8%, the highest point since February, 1923. Since then the yield has gradually fallen following the seasonal decline.

The average yield for the four years, 1923 to 1926, was 75.96%. The yield for the entire year of 1923 was 76.6%, for 1924 it was 75.3%, 1925, 75.5% and for 1926 it reached 76.3%.

Probably one of the reasons for the gradual falling off of the dressing percentage during 1923 and 1924 was the low corn-hog ratio at that time. Corn in relation to hogs was high in price and

as a result every hog feeder was using his best knowledge to utilize feeds that were cheaper than corn and many mill feeds were fed. This may have had a tendency to produce hogs of lower yield.

The right hand column in Table 1 presents the 4-year average by month for 1923 to 1926. These averages show the seasonal variation. For these years the average dress for the first four months of the year was around 76.5%. There was a gradual decline during the months of May, June, and July, but a slight increase in August, followed by a decline in September, October, and November when a low for the 4-year average of 74.9 was reached. In December hogs yield better and the average reached 76.1%.

On the basis of hogs selling for around $10.00 per hundredweight, a difference of 1% in dressed weight makes a live weight difference of approximately 15 cents per hundred pounds. This is an additional fact for the hog producer to keep in mind when the low hog prices occur in the fall months. It is also at this period that the dressing percentages are low.

Probably one of the principal reasons for low yields during the early fall is the large amount of new corn that is used in finishing hogs that are marketed at this time. The early summer months is another period when hogs are very likely to dress low. Such hogs are often fattened on grass pasture and are termed "grass hogs" in the market. Livestock men say it is difficult to get these hogs to make a good yield.

Should the method of marketing hogs on yield continue to increase and prove worthwhile, livestock producers will become more interested in yields and will want to know more of the conditions and factors which affect the dressing percentages of the hogs sold for slaughter.

NUMBER AND SIZE OF FARMS IN OHIO

J. I. FALCONER

There were 276,719 farms in Ohio in 1900, as reported by the Census; in 1925 the number was 244,703, a decrease of 11.5 percent. The average size of farms in the State increased from 88.5 acres in 1900 to 91.6 acres in 1920, but decreased to 90.8 acres in 1925. It would seem that, while the tendency from 1850 to 1900 was for the average size of Ohio farms to decrease, the tendency since 1900 has been for somewhat of an increase in size.

Farms in Ohio

Size	1900	1910	1920	1925	Decrease 1900 to 1925
	No.	*No.*	*No.*	*No.*	*Pct.*
Under 20 acres	35,462	38,913	31,479	31,424	11.39
20 to 49 acres	57,566	50,331	44,535	42,232	26.64
50 to 99 acres	89,774	88,047	86,337	81,537	9.18
100 to 174 acres	67,258	68,746	69,738	65,978	1.90
175 to 259 acres	18,361	18,211	17,371	16,710	8.99
260 to 499 acres	7,218	6,902	6,402	6,062	16.02
500 to 999 acres	916	783	728	664	27.51
1000 acres and over	164	112	105	96	41.46
Total	276,719	272,045	256,695	244,703	11.57

In the table are given the trend in number of farms by size groups since 1900, and the percentage increase or decrease of number of farms in each group. It will be noted that while the decrease in total number of farms in the State for the period was 11.5 percent, farms of less than 50 acres and those over 260 acres decreased in number more rapidly than the average. Farms from 50 to 99 acres and from 175 to 259 acres showed a decrease in relative importance slightly less than that for all farms, while farms from 100 to 175 acres showed only a very slight decrease in number. These data would, therefore, indicate that neither the small farms nor the very large farms are increasing in importance in Ohio, but that it seems to be farms in the group of 100 to 175 acres in size that are increasing in relative importance.

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

The general trend of commodity prices has continued downward. During the year 1926 this downward trend of the general price level was influenced largely by the drop in price of the farm products group. Since January 1927 the decline has been largely due to lower prices in the non-agricultural group, while the prices of the farm products group, both in the United States and in Ohio, have remained nearly at the same level. In January non-agricultural products prices were eleven points above Ohio farm prices. In May they were six points above.

As to wages, the average wage for farm labor in Ohio per month, with board, in July 1924 was reported as $37.00; in 1925 $37.00; in 1926, $40.00; in 1927, $39.25. In January of 1927 the level of farm wages in Ohio was 18 points above last year; in April, 3 points above; and in July, 2 points below. Apparently the decrease of industrial employment is being reflected in farm wages.

While the average price level of all Ohio farm products has remained fairly constant since January there have been fluctuations with individual products. Hogs have declined in volume while grain crops have advanced. Eggs has been low in price since January.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Non-agricultural products U. S.	Farm products prices U. S.	Ohio farm wages	Prices Ohio farm lands	Farm products prices Ohio
1913	102	...	105	100	104	...	104
1914	100	100	97	102	102	...	105
1915	103	101	101	100	103	100	106
1916	130	114	138	117	113	104	121
1917	181	129	182	176	140	111	182
1918	198	160	188	200	175	119	203
1919	210	185	199	209	204	126	218
1920	230	122	241	205	237	146	212
1921	150	203	167	116	164	122	132
1922	152	197	168	124	145	109	127
1923	156	214	171	135	166	108	134
1924	152	218	162	134	165	104	133
1925	161	223	165	146	165	97	159
1926	154	228	161	136	170	96	155
1926							
May	154	226	160	139	...	...	161
June	155	228	160	139	...	...	161
1927			156				
January	150	232	155	126	169	...	145
February	149	231	153	127	...	...	145
March	148	234	151	126	...	90	144
April	147	230	150	125	172	...	144
May	147	230	150	126	...	...	144
June	...	...	...	...	...	...	144
July	...	...	...	...	174	...	...

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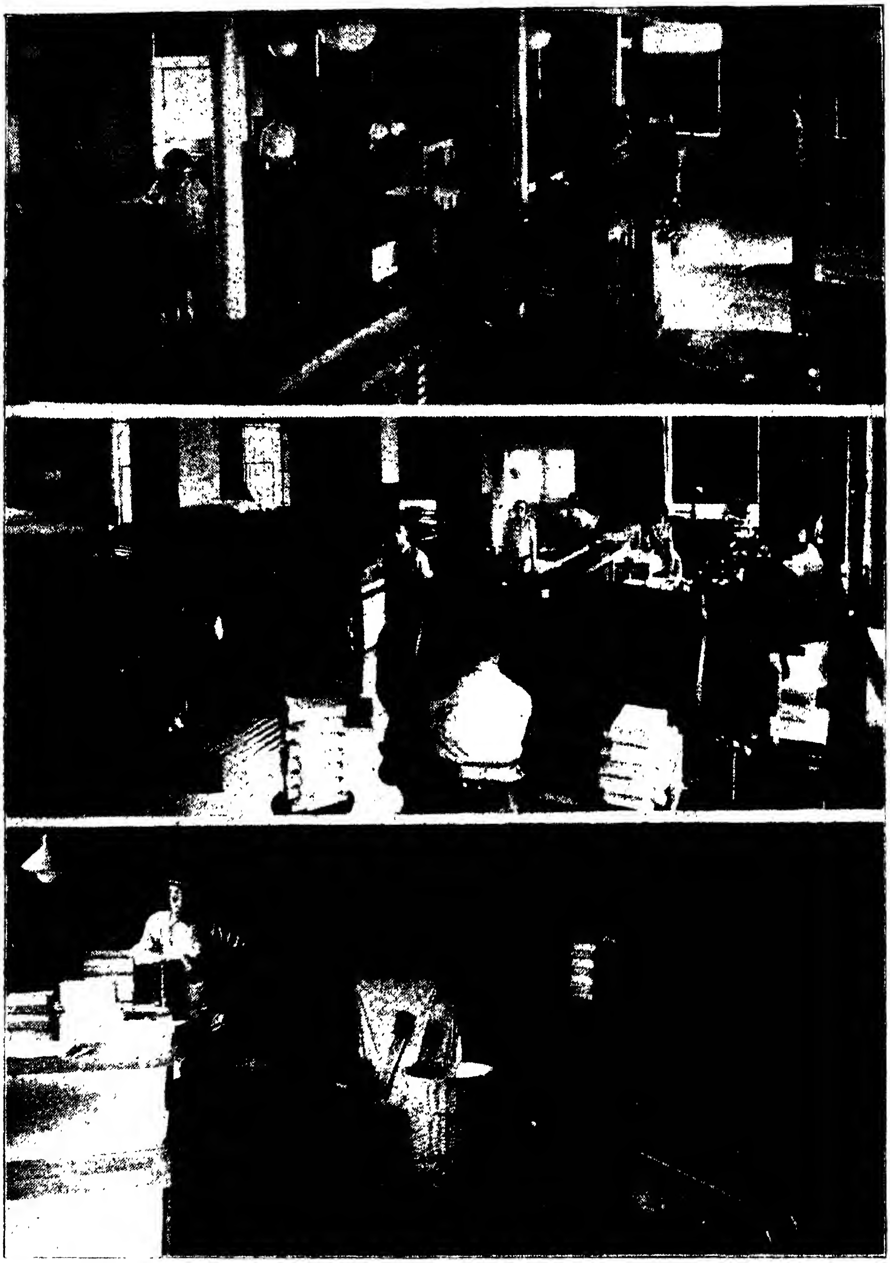

The Experiment Station Printery

Composing room (upper picture), Press room (middle picture), and Bindery (lower picture)

SHOCK CORN FOR HEIFER CALVES

STEERS COMPARED WITH HEIFERS. FINISHING HEIFERS ON PASTURE VERSUS IN DRY-LOT

G. BOHSTEDT

The Hereford calves used in this experiment were raised in the mountain pastures of northern New Mexico, having been purchased last November of the Chas. Springer Cattle Company of Cimarron, N. M. The heifers cost $30 and the steers $33 per head at the ranch or the point of loading. The shipping costs were $4.42 per head from Springer, N. M., to Wooster, Ohio. The heifers weighed 361 pounds and cost $10.33 per cwt. on December 21, at the start of the feeding test. The steers (Lot 6 in Table 1) weighed 369 pounds and cost $10.91 per cwt. All calves were fed various rations for 154 days, until May 24, 1927. Six out of the ten lots were at that time sold off experiment. The other four, Lots 7 to 10, were two weeks later turned on pasture to be fattened and sold in September.

The problem of feeding shock corn is important in Ohio where many cattle are fattened on fodder hauled from the field directly to the feed lot. Corn silage is sometimes fed in conjunction, and seems to be getting more popular. It is at times found expedient to run the shock corn thru a silage cutter, or similar machine, for cutting it into short lengths. Refuse of this sort, having in mind the corn borer problem, is thus more easily trampled into the manure than are long stalks. Feeding shock corn is a practice on many farms because of saving the labor of husking. If such corn should be found to require the labor of cutting it into short lengths, say 1 inch, as was done in this experiment, the cost of silo filling will be approximated without a corresponding efficiency in the utilization of the coarse stalks.

Shock corn, whether cut or long, or fed in several combinations, in this experiment did not produce the gain in the calves that shelled corn did. This in spite of the fact that almost the same amount of corn was consumed by the shock-corn calves. The ears in the shock corn standing exposed to the damp winter weather did not dry out as well, showing from 2 to 4 times as many moldy kernels as the crib-cured corn. The stover in the shock corn was palatable during the early part of the winter, but became less and less so, drying out and weathering greatly during March and April, when nearly all of it went into the bedding. The silo would have saved it.

TABLE 1.—Shock Corn Compared With Shelled Corn Ration for Heifer Calves (Herefords) Steers Compared With Heifers

Heifers and steers were fed from December 21, 1926 to May 24, 1927—154 days	Lot 1 Heifers Long shock corn Oil meal Alfalfa hay Silage	Lot 2 Heifers Cut shock corn Oil meal Alfalfa hay Silage	Lot 3 Heifers Cut shock corn Oil meal Alfalfa hay	Lot 4 Heifers Cut shock corn Oil meal Silage	Lot 5 Heifers Shelled corn Oil meal Alfalfa hay Silage	Lot 6 Steers Shelled corn Oil meal Alfalfa hay Silage	Lot 7 Heifers Oil meal Alfalfa hay Silage	Lot 8 Heifers Alfalfa hay Silage
Number of cattle per lot	10	10	10	10	10	10	10	10
Number of hogs following*	6	5	5	5	6	6	......	......
Cost of heifers and steers per head at ranch, November	$30.00	$30.00	$30.00	$30.00	$30.00	$33.00	$30.00	$30.00
Cost per cwt. at start of experiment, Dec. 21	$10.33	$10.33	$10.33	$10.33	$10.33	$10.91	$10.33	$10.33
Average weight at start of experiment, Dec. 21	362	362	361	360	361	369	360	361
Average weight at end of experiment, May 24	635	659	648	669	719	734	609	538
Average daily gain for 154 days, pounds	1.77	1.93	1.86	2.01	2.33	2.37	1.61	1.15
Average ration, pounds:								
Shelled corn (fed as shock corn to Lots 1, 2, 3, 4)	7.0	7.3	8.9	7.2	8.7	8.7	......	......
Corn stover (fed as shock corn to Lots 1, 2, 3, 4)	6.8	7.0	8.6	7.0	......	......	......	......
Linseed meal	2.0	2.0	1.3	2.5	2.0	2.0	2.0	......
Alfalfa hay	1.5	1.6	2.4	......	1.6	1.6	3.1	5.4
Corn silage	6.4	6.7	......	10.7	7.5	7.8	21.3	17.3
Feed required for 100 pounds gain, pounds:								
Shelled corn (fed as shock corn to Lots 1, 2, 3, 4)	396	379	476	359	374	365	......	......
Corn stover (fed as shock corn to Lots 1, 2, 3, 4)	384	364	462	350	......	......	......	......
Linseed meal	113	104	68	123	86	84	124	......
Alfalfa hay	84	83	130	......	69	68	192	469
Corn silage	359	347	......	532	324	329	1319	1501
Cost of 100 pounds gain	$10.12	$10.17	$10.34	$10.01	$ 7.99	$ 7.85	$ 8.43	$8.45
Necessary selling price at Wooster to break even	$10.33	$10.13	$10.20	$10.05	$ 9.03	$ 9.25	$ 9.56	$9.71
Selling price at Wooster (Cincinnati price less 90 cents)	$ 9.95	$10.10	$10.10	$10.10	$10.60	$10.85	$ 9.10	$8 60
Selling price at Cincinnati	$10.85	$11.00	$11.00	$11.00	$11.50	$11.75	$10.00	$9.50
Returns per head over feed costs:								
Excluding hogs	$—1.84	$—1.04	$—1.53	$—.54	$10.31	$10.74	$—2.78	$—5.97
Crediting hog profits	$ .67	$ 1.40	$ .93	$ 1.92	$12.71	$13.52	$—2.78	$—5.97
Crediting feed saved by hogs	$ —.76	$ —.17	$ —.66	$ .33	$11.30	$11.76	$—2.78	$—5.97

*Due to a rather poor grade of pigs, substitutions were called for in every lot, making the hog data rather unsatisfactory.

Prices of feed: Shelled corn (No. 2 moisture basis) 64 cents per bushel, linseed meal $52, alfalfa hay $20, corn stover $8, corn silage $5 per ton. Corn in cut shock corn was here provisionally valued at the same price per bushel as shelled corn. Cost of cutting shock corn was placed at $1.50 per ton. Hogs were valued at $12.00 at the beginning and $9.50 at the end of the feeding period.

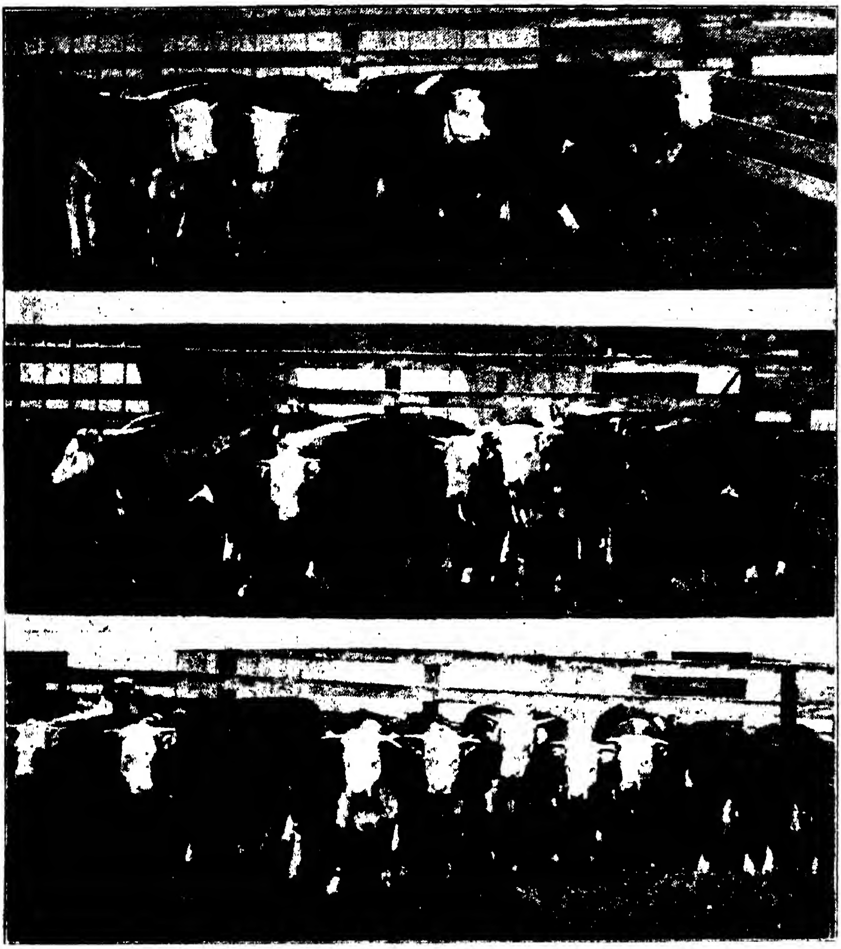

Fig. 1.—Upper picture.—Heifers of Lot 2, fed cut corn fodder, oil meal, alfalfa hay, and corn silage, failed to eat as much corn and silage as they would have if given shelled corn. They made somewhat smaller and more expensive gains, and with a lower market value did not make the profit produced by heifers fed shelled instead of shock corn.

Middle picture.—These heifers, Lot 5, were fed the standard ration of shelled corn, oil meal, alfalfa hay, and corn silage. This has rather consistently been a profitable ration.

Lower picture.—Steers of Lot 6 in comparison with the above heifers cost 58 cents more per hundredweight at the outset, but made somewhat larger and cheaper gains, selling for 25 cents more on the market, and as a result were fully as profitable to feed as heifers.

The heifers of Lot 5, fed the check ration of shelled corn, oil meal, alfalfa hay, and silage, made considerably better daily gains, 2.33 pounds as against 2.01 pounds for the best gaining lot on a shock corn ration, Lot 4. This better gain and finish resulted in a 50-cents higher market value and a return over feed costs of $11.30 per head, as opposed to practically no gain, or 33 cents per head, for the shock-corn group.

Even tho 10 cents per bushel were allowed for husking the 20 bushels of corn consumed by each heifer in Lot 2, this saving of $2, or corresponding increase in profit per head, would still leave the feeding of shelled corn the more economical practice.

While the shock-corn rations fed to Lots 1 to 4 were relatively uneconomical, attention must be called to the probability that after a month or more of feeding the shock-corn calves would have had as good a finish as the others, and sold for fully as much on a market that, judging from the average price curve of a number of years, would have meanwhile begun to pay a larger premium for cattle of quality and finish.

Again it must be granted that, due to weathering and the advent of warmer weather, shock corn is not as palatable in the spring as in the winter, for this reason it would no doubt be better to quit feeding shock corn soon after April 1, and to feed corn in a more acceptable form. Many cattle feeders, even tho they may feed shock corn, find it advisable to rely rather heavily on corn silage, both while shock corn lasts as well as after it has given out in the spring. In this way they avoid wasting a lot of corn stalks in the manure, which is bound to happen to shock corn in warm weather.

The heifer calves of Lot 1, fed uncut fodder, did not have as easy a variety of ear corn (Clarage) to shell as some cattle feeders are wont to grow for their fattening cattle. This shelling factor did not enter into the showing of Lots 2, 3, and 4, which were fed fodder run thru the silage cutter, which effectually shelled the kernels off the cobs, however raising the cost of fodder $1.50 per ton. The calves so fed gained 1.93 pounds per head daily, as compared with 1.77 pounds for Lot 1 fed long shock corn. The financial outcome of the cut-fodder feeding was the better of the two systems.

The one redeeming feature of feeding long corn directly out of the shock is, as has been indicated the saving of labor where this is scarce. Calves in the feed lot quickly become used to eating unhusked ear corn, particularly if it happens to be of an easy shelling variety

Unless the long stalks are thoroly trampled into the manure or are burned or plowed under, they constitute a danger from the standpoint of harboring corn borer larvae. The cutting or shredding of stalks in itself kills most of the larvae, or at least puts the refuse corn stover in shape to be readily trod into the manure by the cattle, in this way rendering the material relatively harmless. Converting a corn crop into silage, where this is feasible, is, of course, the most effective way of destroying corn borer larvae.

Fig. 2.—Prosperous in appearance and profitable in outcome

These calves of Lot 9 were finished in dry-lot where they took on a superior finish and sold for enough more than those finished on pasture to make the dry-lot the more profitable system.

Lots 7 and 8 in Table 1 were simply carried thru the winter preparatory to being finished on pasture. Lots 9 and 10 in Table 2 were fed similar winter rations. These were calves that, while of just as good quality as the rest, were younger and lighter in weight and for that reason were segregated into these two lots at the start of the experiment, December 21, 1926. On account of this difference in age and weight their record is not quite comparable with that of any of the first eight lots, more particularly Lots 7 and 8. They are, however, placed side by side in Table 2, in that they carry a lesson. Heifers are discounted on the market if too heavy. Lots 7 and 8 had grown considerably during the winter, and even tho fed ground corn and oilmeal on pasture had not finished very well. Growth during the winter had not hurt the lighter heifers of Lots

9 and 10 so much. Arriving at the Cincinnati market on September 26 they were more compact and "tidy" in appearance, especially Lot 9, fed the dry-lot ration, which furnished a striking contrast to the others and topped the market for the day. This result emphasizes that of the previous year when calves finished in dry-lot returned a greater profit than those finished on pasture. The impulse to grow rather than fatten is strong in calves. Pasturing seemed to accentuate that impulse, so that in spite of corn and oilmeal in the ration it did not produce as desirable a market finish as the dry-lot feeding.

TABLE 2.—The Effect of Varying Amounts of Oilmeal in Stocker Rations of Heifers to be Finished on Pasture. Finishing Heifers in Dry-lot Versus on Pasture

Rations in dry-lot	Lot 7	Lot 8	Lot 9	Lot 10
	Heifers of same age as first 6 lots		Younger heifers	
	Oilmeal 2 lb., Alfalfa hay Silage	Alfalfa hay Silage	Oilmeal 2 lb., Alfalfa hay Silage	Oilmeal 1 lb., Alfalfa hay Silage
Dry-lot feeding period, December 21, 1926, to June 7, 1927—168 days				
Number of heifers per lot	10	10	10	10
Cost per cwt at start of experiment, Dec. 21	$10.33	$10.33	$10.33	$10.33
Average weight Dec. 21	360	361	316	307
Average weight June 7	635	554	594	550
Average daily gain for 168 days	**1.64**	**1.16**	**1.65**	**1.44**
Average ration:				
Linseed meal	2.0	....	2.0	1.0
Alfalfa hay	3.1	5.5	3.1	3.5
Corn silage	22.0	17.8	19.4	18.6
Feed for 100 pounds gain:				
Linseed meal	122	....	121	70
Alfalfa hay	189	475	186	244
Corn silage	1345	1546	1171	1289
Cost of 100 pounds gain	**$8.43**	**$8.61**	**$7.93**	**$7.47**
Pasture feeding period (Lot 9 in dry-lot) June 7 to September 23—108 days				
	Gr. corn Oilmeal Pasture	Gr. corn Oilmeal Pasture	Gr. corn Oilmeal Alfalfa hay Silage	Gr. corn Oilmeal Pasture
Average weight June 7	635	554	594	550
Average weight Sept. 23	766	709	746	675
Average daily gain for 108 days	**1.21**	**1.44**	**1.44**	**1.16**
Average ration:				
Ground corn	7.9	8.4	8.1	7.2
Linseed meal*	1.4	1.4	2.0	1.4
Alfalfa hay	....	....	1.5	....
Corn silage	.06	.08	11.8	.07
Feed for 100 pounds gain:				
Ground corn	656	585	562	622
Linseed meal	114	95	139	119
Alfalfa hay	....	....	103	....
Corn silage	5	5	817	6
Cost of 100 pounds gain	**$15.29**	**$13.53**	**$17.32**	**$14.84**

*From June 7 to August 17 one pound of oilmeal was fed to the heifers on grass, after that two pounds.

TABLE 2.—**The Effect of Varying Amounts of Oilmeal in Stocker Rations of Heifers to be Finished on Pasture. Finishing Heifers in Dry-lot Versus on Pasture—Continued**

Rations on pasture (Lot 9 in dry-lot)	Lot 7	Lot 8	Lot 9	Lot 10
	Heifers of same age as first 6 lots		Younger heifers	
	Gr. corn Oilmeal Pasture	Gr. corn Oilmeal Pasture	Gr. corn Oilmeal Alfalfa hay Silage	Gr. corn Oilmeal Pasture
Combined dry-lot and pasture period (Lot 9 in dry-lot from start to finish) December 21, 1926, to September 23, 1927—276 days				
Average weight Dec. 21, 1926	360	361	316	307
Average weight Sept. 23, 1927	766	709	746	675
Average daily gain, 276 days	**1.47**	**1.26**	**1.57**	**1.33**
Average ration:				
Ground corn	3.1	3.3	3.1	2.8
Linseed meal	1.8	.53	2.0	1.2
Alfalfa hay	1.9	3.3	2.5	2.1
Corn silage	13.4	10.8	16.4	11.3
Feed for 100 pounds gain:				
Ground corn	211	261	199	212
Linseed meal	120	42	127	86
Alfalfa hay	128	263	157	160
Corn silage	914	859	1046	851
Cost of 100 pounds gain	**$10.67**	**$10.80**	**$11.25**	**$9.90**
Necessary selling price at Wooster to break even	$10.51	$10.56	$10.86	$10.14
Selling price at Wooster (Cincinnati price less 90 cts.)	$11.10	$10.85	$12.60	$11.35
Selling price at Cincinnati, Sept. 26	**$12.00**	**$11.75**	**$13.50**	**$12.25**
Return per head over feed costs (Pasture charge included)†	**$2.56**	**$.08**	**$13.01**	**$6.18**

Prices of feeds: Ground corn (No. 2 moisture basis) $1.06 per bushel during pasture season, linseed meal $52, alfalfa hay $20, corn stover $8, corn silage $5 per ton.

†Pasture was charged at $6 per acre for a 5½ months' grazing season. It is estimated that each calf used one-half acre during 108 days of the grazing season, resulting in a pasture charge of $1.96 per head.

Shipping and slaughter data are incomplete due to using most of the cattle on a demonstration tour, and to the necessity of selling to several packers instead of one. For the cattle shipped from Wooster to Cincinnati, September 24 to 26, 1927, the shrinkages were: Lot 7, 3.2%; Lot 8, 3.1%; Lot 9, 3.5%; and Lot 10, 2.5%. For two feeds previous to loading corn and silage were reduced to half and the calves were fed what mixed hay they cared for.

Summary.—Feeding shock corn, either long or cut, was less economical under the conditions of this experiment than feeding shelled corn in the same combination of feeds.

Conditions or changes from the system of feeding here employed, are pointed out that might enable shock-corn rations to make a more favorable showing.

During several experiments now the ration of shelled corn, a high-protein concentrate such as oilmeal, legume hay, and corn silage, with hogs following the cattle in dry-lot, has consistently been a relatively economical ration to feed.

Steer calves, in spite of a 58-cent higher initial cost per hundredweight, held their own against heifer calves, in that they made somewhat larger and cheaper gains, and sold for 25 cents more per hundredweight at the end of the experiment.

Fig. 3.—Livestock Day, Wooster, May 27, 1927

The several lots of livestock are penned outside for the day so that visitors may easily compare the results of the various experiments.

It paid to feed oilmeal in winter rations of calves that were to be finished on pasture.

Finishing heifer calves on pasture, by feeding corn and oilmeal, proved less economical than finishing in dry-lot.

SHOCK CORN FOR YEARLING STEERS

District and County Experiment Farms and Department of Animal Industry.
Steers Fed at the Madison County Experiment Farm

H. W. ROGERS* AND G. BOHSTEDT†

Differing from the cattle in the previous experiment, these were yearling steers, grade Shorthorns, that were purchased about the first of the year at Chicago, grading as good feeders, priced at $7.50. They cost $8.08 laid down at London, Ohio, where at the Madison County Experiment Farm they were fed for 119 days, January 18 to May 17, 1927. Again a shock corn ration was compared in economy and ability to produce gains with a shelled corn ration, where cottonseed meal, however, instead of linseed meal was

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†Chief Animal Industry Department.

fed, and clover hay instead of alfalfa hay, with corn silage. As compared with the heifer calves in the other test, these were yearling steers, a somewhat cheaper grade of feeders, fed a shorter period, and obviously pointing toward a different market.

The gains on the two rations, a cut shock-corn as compared with a shelled-corn ration, were very similar, 2.54 pounds and 2.58 pounds, daily per head, respectively. Contrary to the behavior of the heifer calves, these yearling steers ate more corn in the cut shock corn than in the shelled corn ration. An examination indicated that not as much moldy corn was present in the shock corn at London as in that at Wooster. The yearlings at London also utilized the stover better than did the calves at Wooster. This may be due to the fact that the shocks of corn were considerably larger and, therefore, did not weather as much as those at Wooster.

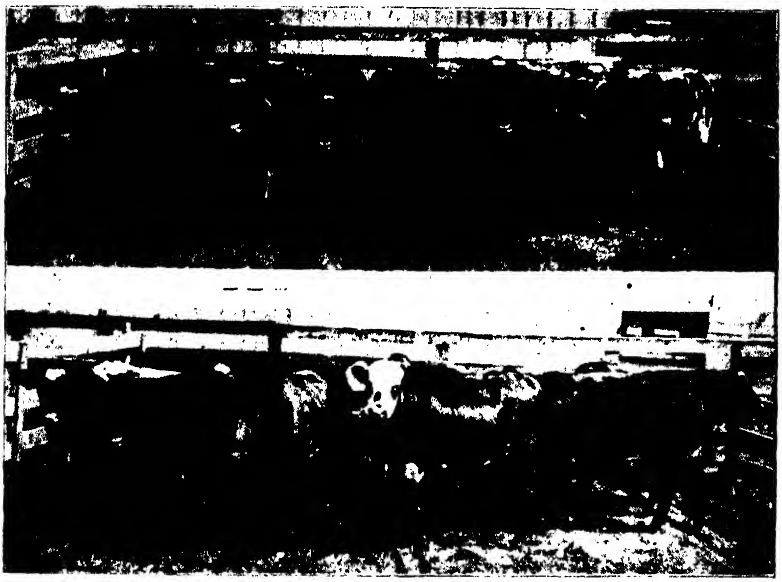


Fig. 4.—Upper picture.—Lot 1, fed shelled corn. Average daily gain 2.58 pounds, returns over feed costs 9.29.

Lower picture.—Lot 2, fed shock corn. Average daily gain 2.54 pounds, returns over feed costs $6.21.

Until further cost data are secured the corn in cut shock corn has on the same dry-matter basis been valued at the same price per bushel as shelled corn from crib corn. The cost of cutting the corn was estimated at $1.50 per ton. With the gains so nearly equal and both lots of steers valued at the same price, $10.25, on the basis of

the Cleveland market, the lower cost of gains of the shelled corn ration resulted in a slightly larger return over feed costs, or $9.29 as compared with $6.21 for the shock-corn steers.

As in the previous experiment; even tho it be granted that as much as 10 cents per bushel was saved by not needing to husk the 22 bushels of corn consumed by each steer in Lot 2, amounting to a saving of $2.20 per steer from feeding the corn unhusked, this saving, or increase in profit per head, would still leave the shelled corn ration of Lot 1 fully as profitable as the shock-corn ration.

TABLE 1.—Shock Corn Compared With Shelled Corn Ration for Yearling Steers (Shorthorns)

Steers were fed from January 18 to May 17, 1927—119 days	Lot 1 Shelled corn Cottonseed meal Clover hay Corn silage	Lot 2 Cut shock corn Cottonseed meal Clover hay Corn silage
Number of steers per lot	15	15
Number of hogs following the steers	10	10
Cost of steers at Chicago, Jan. 5	$7.50	$7.50
Cost of steers laid down, London, Ohio	$8.08	$8.08
Cost of steers at start of experiment, Jan. 18	$8.10	$8.10
Average weight at start, pounds	607	604
Average weight at end, pounds	914	906
Average daily gain, pounds	2.58	2.54
Average daily feed, pounds:		
Shelled corn (fed as shock corn to Lot 2)	8.5	10.2
Corn stover (fed as shock corn to Lot 2)	....	14.7
Cottonseed meal	2.0	2.0
Clover hay	2.1	1.3
Corn silage	33.0	15.0
Feed required for 100 pounds gain, pounds:		
Shelled corn (fed as shock corn to Lot 2)	330	402
Corn stover (fed as shock corn to Lot 2)	....	580
Cottonseed meal	76	77
Clover hay	80	51
Corn silage	1278	590
Cost of 100 pounds gain	$ 9.19	$10.87
Necessary selling price at feed lot to break even	$ 8.33	$ 8.66
Selling price at feed lot (Cleveland price less 90 cents)	$ 9.35	$ 9.35
Selling price at Cleveland, May 27	$10.25	$10.25
Return per steer over feed costs:		
Excluding hogs	$ 8.08	$ 4.48
Crediting hog profits	$11.03	$ 8.13
Crediting feed saved by hogs	$ 9.29	$ 6.21

The feed prices prevailing at Wooster which are higher than those at London, Ohio, are: shelled corn (No. 2 moisture basis) 64 cents per bushel, cottonseed meal $40, clover hay $18, corn silage $5, corn stover $8 per ton. Corn in the shock was here provisionally valued at the same price per bushel as shelled corn. Hogs were valued at $12.00 at the beginning and $9.50 at the end of the feeding period.

FUMIGATING GREENHOUSES WITH CALCIUM CYANIDE

GEO. A. FILINGER

Calcium cyanide, a compound developed in the last few years, is proving a very convenient source of hydrocyanic acid gas used for the fumigation of greenhouses. This new compound is fast taking the place of sodium and potassium cyanides which have been used for fumigation for a long time. It does not require the use of jars nor the addition of sulphuric acid, as the other compounds do.

Gas generated by the old "pot method" was liberated almost instantly, giving a high concentration within a few minutes. Calcium cyanide, when exposed, slowly reacts with the moisture of the atmosphere and thus liberates the deadly gas gradually, giving a lower concentration over a longer period. This makes it safer, both to plants and to man, and probably gives a better insect control because of a more thoro penetration.

The use of calcium cyanide not only insures better control and is safer but it is also cheaper and more convenient. The cost of this material for fumigating a thousand cubic feet of space is about ½ cent, while the cost of materials for the old method to fumigate an equal volume is about 2 cents.

PREPARATION FOR FUMIGATION

The plants must be dry. Avoid watering for at least 24 hours before attempting to fumigate with calcium cyanide. Make sure that the temperature is between 55° and 70° F. and is rising rather than falling. A rising temperature will prevent moisture from collecting on the leaves. Burning may result if plants are wet.

Do not use copper sprays, such as bordeaux mixture, or copper dusts, such as copper-lime or "D6", preceding fumigation as hydrocyanic-acid gas reacts with the copper to form a poisonous substance which is toxic to plants. If it is necessary to spray with copper fungicides, do this after the fumigation.

Tightly close all ventilators, replace broken glass, and fill other openings to prevent gas from escaping. Where various crops are grown in open range houses it may not be desirable or necessary to fumigate the entire range at the same time. In such cases a muslin or canvas curtain can be used to completely separate the houses or portions of houses.

Calcium cyanide for greenhouse fumigation can be obtained from local dealers under the trade name of "Cyanogas G-fumigant", manufactured by the American Cyanamid Company; or as Calcium Cyanide, Grade No. 9, manufactured by the California Cyanide Company.

Fig. 1.—A fruit jar with a hole in the cap is convenient for distributing calcium cyanide

It is very important to determine carefully the proper dosage. The amount of cyanide to use depends upon the tightness of the house, the insects to be controlled, and the hardiness of the plants. As houses vary considerably in construction, it is a good plan to start by using a small amount of the cyanide and gradually increase the dosage in order to avoid injury to the plants and waste of material. Since 1/8 ounce per 1,000 cubic feet is considered safe for most plants under normal conditions, the number of cubic feet in the house to be fumigated divided by 8,000 gives the minimum number of ounces of calcium cyanide to use. The dosage may have to be increased to 1/4 ounce, or double this amount, which is the amount commonly used, particularly on the more hardy plants. In some instances it may be necessary to use as much as 1/3 ounce or even 1 ounce per 1,000 cubic feet. If it is inconvenient to weigh the cyanide out, it may be measured at the rate of two level tablespoon-

fuls to an ounce. The required quantity is weighed out and placed in closed containers, such as mason fruit jars. A convenient distributer may be made by removing the porcelain from a fruit jar lid and punching a hole about ½ inch in diameter thru the cap a little to one side of the center. Thru this opening the material can be distributed. See Figures 1 and 2. A glass container is preferred as the operator can better gage the rate of distribution.

THE FUMIGATION

Fumigation of greenhouses should be done on still, clear evenings not earlier than an hour after sunset. Winds or air currents tend to draw the gas out of the house and wet, muggy weather increases the possibility of burning the plants. Extremely cold nights in winter should be avoided as it is difficult to maintain the proper temperature. In summer hot, humid nights are to be avoided.

The calcium cyanide is distributed evenly along the middle path if the house is narrow, or on several walks if the house is wide or several houses are to be fumigated. If several walks are to be

Fig. 2.—Distributing calcium cyanide on walk in a greenhouse

covered, it is best and safest to have a man for each walk. Start at the far end of the house and, walking backwards, hold the distributing can close to the walk and pour the cyanide in a line down the middle (Fig. 2). If the container is held high during the distributing process some of the finer particles of cyanide may lodge upon the leaves of plants and cause burning. Continue walking back toward the door, distributing the cyanide so as to empty the container by the time the door is reached. It will not be safe to enter the house until the next morning, when practically all of the gas will have disappeared.

Frequency of application depends upon the insects to be controlled. If the first application fails to give control fumigation should be repeated. Insect eggs, pupae, and even immature insects offer considerable resistance to fumigation. Where these stages occur it may be necessary to repeat the fumigation when the adult stage is reached. With scale insects, the mature stage is resistant and the very young stages are most easily controlled.

PRECAUTIONS

Great care should always be exercised in handling calcium cyanide. It should be stored in air-tight containers and properly labeled. Weighing should be done rapidly to avoid exposure to fumes. Once the correct dosage is determined it can be marked on the distributing jars and from then on the material can be measured out. Never pour calcium cyanide into standing water on walks. The walks may be moist, but the material works well even when they are dry, and there is less danger of burning the plants by too rapid a liberation of gas. Do not attempt to use sulphuric acid with this material. The use of calcium cyanide is not recommended where greenhouses adjoin dwelling places. Doors leading to greenhouses that are being fumigated should be marked so as to warn anyone about to enter.

ADVANTAGES OF THE NEW METHOD

1. The material is easy to apply and much safer to use than the other compounds of cyanide.
2. The material is easily stored.
3. Aeration of greenhouses is unnecessary after fumigation, thus avoiding chilling of plants.
4. Lower concentration of gas over a longer period insures a more thoro kill and a greater margin of safety.
5. The residue is harmless.
6. The cost is much less than that of using the old pot method.

FOR WINTER EGGS MAKE THE HENS EAT MORE

D. C. KENNARD

Profitable winter egg production is always associated with heavy feed consumption. The amount of feed consumed is a direct index to rate of production. When the feed consumption of a flock is heavy it means the majority of the birds either are or soon will be laying.

A hen requires 5 or 6 pounds of feed a month just to live. For profitable egg production she must eat about a pound more. Whether the birds are induced to eat the extra pound a month depends largely upon the ration and method of feeding. Little profit comes from the first five pounds of feed unless the extra pound is also consumed. The profit, therefore, comes mostly from the additional one pound per month. Hence profitable egg production, especially during winter, depends largely on how much feed the poultry keeper can induce the fowls to eat. He may increase feed consumption in a variety of ways. No set rule will serve poultry keepers in general, as each is surrounded by different conditions so that he must develop a procedure best adapted to his requirements. However, there are certain principles which have a general application and some of these will now be considered.

MAKING THE LAYERS EAT MORE

1. **Feed a complete ration.**—A ration deficient in any respect lessens the fowl's appetite

2. **Employ a mash the birds like.**—The palatability of a mash depends upon the ingredients and their quality. A mash made mostly of granular material is more readily consumed than when finely ground.

3. **Use a suitable type of mash feeder** and supply 20 to 24 feet of eating space for each 100 layers. The reel mash feeders made 7 to 11 inches wide and 4 inches deep on inside are well adapted for this purpose.

4. **Feed fresh mash daily** in the evening in about the amount that will be consumed before the next feeding. The birds relish fresh mash and if it is fed in the evening they will go to roost with better filled crops. During severe winter weather a small amount of fresh mash can be fed to advantage in the morning and at noon.

5. **Milk** in some form is an appetizer and usually aids in securing greater feed consumption. It is also a valuable addition to the ration for its nutritive properties.

6. **Lights** in the poultry house aid in securing increased feed consumption by making the days longer. Any of the methods for use of lights may be employed to advantage.

7. **Moist mash** may prove beneficial, especially if skillfully used. The skill and extra labor necessary for success with moist mash may make its use questionable, in some instances. Moist mash fed without the proper skill and judgment often does more harm than good. However, if properly managed, a moist mash can be used to considerable advantage for the layers during the later summer, fall, and winter months.

METHODS OF FEEDING MOIST MASH

Mixing water or milk with dry mash to form a slightly moistened or crumbly mixture is the usual method of preparing moist mash.

Wetting by pouring or sprinkling water or milk on the mash in the feeder is another method. Altho not often employed it is simple, avoids the trouble of mixing, and perhaps requires no more or even less skill than the usual method. The mash in feeder is smoothed over before wetting so as to leave it about an inch higher at the sides and ends of the feeder. This provides a sort of trench or receptacle for the water or milk and prevents it from coming in contact with the mash box. The desirable depth of dry mash is about 1 inch in center and 2 inches at side and ends of the box. The amount of water or milk to be added will vary but it usually will range from ½ to 1 gallon per 100 birds. A ten-quart sprinkling can is very convenient for wetting the mash.

Precaution.—If any of the wet mash adheres to the box it should be scraped loose the next morning, so the hens will eat the moist portion before it becomes sour or musty. A small hand scraper about eight inches long with blade about three inches wide is very convenient for this purpose. Since the birds relish the wet mash mixture very much, skill and careful judgment must be exercised in feeding it.

Time to feed moist mash.—With either method probably the best time for feeding the wet or moistened mash is just before the birds go to roost so their crops will be well filled for the night. Some prefer feeding the wet mash at noon. When the evening lunch procedure of using artificial lights is followed, undoubtedly

evening would be the best time. Even if the caretaker chooses to mix the moist mash rather than let the hens do it, as in the case of the wetting method, no separate boxes or troughs are required, provided there is ample feeding space (20 to 24 feet per 100 layers) for the dry mash. Simply put the moistened mash in the mash feeders on top of the dry mash. This makes a clean place for feeding it and should there occasionally be a small amount left over in the evening the birds will eat it the first thing in the morning. For best results with either procedure during cold weather hot water or milk should be used.

A moistened mash when fed regularly makes a desirable way of administering cod-liver oil in the ration. Two to four ounces of the oil can be added directly to the moist mash for each 100 layers daily. This obviates mixing the oil in with the dry mash and avoids any chance for deterioration after it is mixed with the dry feed.

MORE MASH FOR EITHER ALL-MASH OR SCRATCH GRAIN AND MASH METHODS OF FEEDING

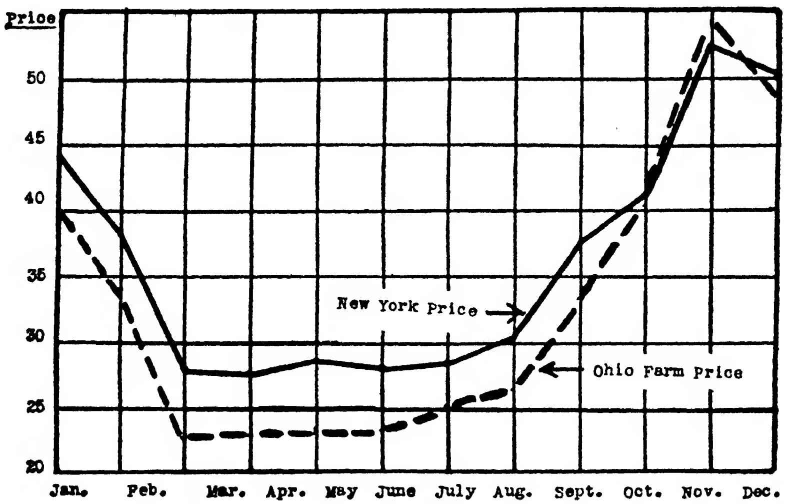
The foregoing suggestions are intended either for the all-mash or the scratch grain and mash methods of feeding. When scratch grain is fed separately considerable attention should be given to the proportion of mash to grain. The birds naturally eat the grain more readily if given the chance and consume proportionately less mash. So it is important when scratch grain is fed separately to employ some means to induce the birds to eat more mash. Hence the same suggestions apply to both methods of feeding.

Finally it should be emphasized that for profitable fall and winter egg production the poultry keeper must not only feed a complete ration but he must endeavor to secure the additional consumption of feed required for producing eggs, and maintainance of body weight during cold weather. To succeed in this the birds will need considerable attention and skillful feeding and management.

A COMPARISON OF OHIO AND NEW YORK EGG PRICES

V. R. WERTZ

A comparison of the monthly wholesale price of eggs in New York City with the farm price of eggs in Ohio for the past five years indicates that the spread between the Ohio farm price and the New York price of eggs (fresh firsts) is relatively high in the months of March, April, May, and June and relatively low in the months of October, November, and December. On the average, the wholesale price of fresh firsts at New York was 0.8 cent above the Ohio farm price in the month of October, 0.8 cent less than the Ohio farm price in November, and 1.6 cent higher in December.



The greatest spread between the New York price and the Ohio farm price seems to be in the months of March to June, inclusive. The greatest difference between the farm price and the New York price was 5.6 cents, in March; and the least was in November, when the Ohio farm price exceeded the New York price by 0.8 cent. The reason the Ohio farm price of eggs was nearly equal to the wholesale price of fresh firsts at New York in October, November, and December is not to be found in the fact that receipts at New York increase in these months, for New York receipts are at the lowest point during these three months. The main explanation for this relatively higher price of eggs in Ohio in these three months is to be

found in the fact that Ohio, due to its large industrial population and low production in fall and winter months, ceases to be a surplus egg producing state during the months of October, November, and December.

A Five-Year Monthly Average Price of Eggs in New York City* and in Ohio† (1922-1926, inclusive)

Price	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
New York City	44.4	37.8	28.0	27.6	28.4	27.8	28.0	30.4	37.6	41.8	52.8	51.2
Ohio farm	40.0	33.8	22.4	23.0	23.4	23.4	25.0	27.2	33.4	41.0	53.6	49.6
Difference	4.4	4.0	5.6	4.6	5.0	4.4	3.0	3.2	4.2	0.8	—.08	1.6

(1) Fresh firsts, U. S. Department of Agriculture Yearbook, 1926, page 1170.
(2) Farm prices, Ohio Agricultural Statistics, 1924, page 76 and unpublished data in the office of C. J. West, agricultural statistician, Columbus, O.

ROAD SUPPORT VS. ROAD USE

H. R. MOORE

The development of motor transportation has created an insistent demand for better roads. This demand has stimulated the improvement of our state, county, and township roads to a degree undreamed of a few years ago. The results are gratifying from the standpoint of transportation, but the cost has been a heavy burden on the taxpayers, especially the owners of farm real estate.

DISTRIBUTION OF ROAD COSTS

The accompanying table has been assembled so as to indicate how the funds used on Ohio roads were obtained in the period 1921-1925. The table is intended to cover collections thru direct and indirect taxation. Total capital outlays would include bond issues. Expenditures for city streets are not included in this table.

Uniform property levies account for approximately 69% of the total funds collected. As indicated in columns 1 and 2 of Table 1, a little less than one-half of this 69% was contributed by property owners outside municipal corporations and a little more than one-half came from property owners in municipalities.

In 1921 and 1922 the State collected $10,571,000 by uniform property tax levy for road improvement. In 1923, 1924, and 1925, the only uniform levy for roads was made by the counties and townships.[1]

[1]Ohio Tax Commission report, 1925, Page 152-53.

TABLE 1.—Tax Revenue Collected for Ohio Roads, 1921-1925

Levying jurisdiction	Legal provision under which money was secured								Total	
	Uniform tax levy on property				Special assessments on real estate abutting or near road improvement (3)		Direct and indirect taxes (4)		(5)	
	Outside municipal corporations (1)		Levy on property in municipal corporations (2)							
	Dols. (000 omitted)	*Pct. of total tax*	*Dols.* (000 omitted)	*Pct. of total tax*	*Dols.* (000 omitted)	*Pct. of total tax*	*Dols.* (000 omitted)	*Pct. of total tax*	*Dols.* (000 omitted)	*Pct. of total*
Federal Government (road construction)	....	....	....	....	....	....	16,453	6.01	16,453	6.01
State (construction)	3,142	1.15	7,429	2.72	....	....	13,335	4.87	23,906	8.74
State (maintenance and repair)	....	....	....	....	....	....	28,045	10.25	28,045	10.25
County (construction, maintenance and repair)	27,707	10.13	65,520	23.95	15,206	5.56	8,489	3.10	116,922	42.74
County (road debt payment)	8,545	3.12	20,206	7.38	....	....	....	....	28,751	10.51
Township (construction, maintenance, repair, and road debt payments)	51,986	19.00	3,810	1.39	3,727	1.36	....	....	59,533	21.75
Total	91,380	33.40	96,965	35.44	18,943	6.92	66,322	24.24	273,610	100.—

*Direct and indirect taxes include custom duties, internal revenue, inheritance taxes, excise taxes, franchise taxes, automobile registration fees.

Property owners in municipalities contributed over $65,000,000 to county road funds thru the uniform property tax in this five-year period as compared with $27,707,000 contributed to county road funds by property owners outside municipalities.[2]

County road debt payments by uniform property taxation for the five years amounted to more than $28,000,000. Such debt payments should be considered in conjuncion with the county road funds for construction, maintenance, and repair. These funds, in some instances, include debt payments.

Township road funds, totaling 80% of all township taxes,[3] are collected mainly on property outside municipalities. A small portion of these funds is collected in municipal corporations. The amount so collected is nearly proportionate to the road mileage in municipalities supported by township funds. Columns 1 and 2 of Table 1 indicate that 20.39% of all funds for roads were levied by townships.

Special assessments on property adjoining or near road improvements account for nearly 7% of all road funds collected in this five-year period.[4]

The Federal Government contributed $16,453,000 for road construction in Ohio from 1921 to 1925.[5] This is 6% of the tax funds used in the State for roads. Federal funds are available for use only on "federal aid roads" in the state system. Federal funds are collected partly thru the internal revenue system and partly from custom duties. This revenue cannot be allocated directly to Ohio citizens as contributors. Indirectly Ohio citizens pay their share and federal aid for roads is a return benefit received.

The state revenues contributed to road construction, aside from the general property tax mentioned above, comes from two sources. First, appropriations by the State Legislature are taken from the general revenue fund of the State. Second, various revenues are collected expressly for streets and highways. The important collections under the second heading are the automobile registration fees and the gasoline excise tax. The $8,489,000 in column 4, indicated as county funds, is the local share of automobile registration fees and the gasoline excise tax used on roads outside municipalities.[6]

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[2]Figures derived from grand duplicate of Ohio in state auditor's annual report 1921-1925.
[3]Unpublished data, Department Rural Economics.
[4]Based on report of Joint Legislative Committee of 86th General Assembly, Page 73, and table of grand duplicate of Ohio, Tax Commission's Annual Report.
[5]Data supplied by Dept. of Highways and Public Works.
[6]State Auditor's Annual Report.

Thus far the discussion has been on the distribution of the road costs as analyzed in Table 1. The intention has been to classify payments so that contributions by the rural portion of Ohio citizens may be separated from other payments.

The division of uniform tax levies has been made to separate incorporated from unincorporated territory. This division indicates that unincorporated territory contributed thru the general property tax 33.4% of all revenue collected for roads. Special assessments account for 6.92% of the total collected. Better than 90% of the special assessments for roads fall on property outside municipalities. To be conservative, 6% may be added for special assessments to the 33.4% raised by the uniform property tax, to obtain the total contributed by property owners in the country thru direct property taxation. This 39.4% represents the total direct property tax burden for roads. The more indirect taxes included in column 4 cannot be divided so accurately. However, the $8,489,000 in column 4 may be added to the 39.4%, for this sum is automobile registration fees paid by persons in rural taxing districts, and a small amount of gasoline tax apportioned to rural territory. This adds 3.1% to the 39.4% contributed thru the property tax and assessments, totaling 42.5%.

The remaining 21.14% in column 4 is collected from widely different sources. To divide this revenue on the basis of population is not as accurate a method as is desirable, but it is perhaps the most satisfactory division that can be made. Such a division will add 6% to the 42.5%. The resulting 48.5% represents the portion of the road costs that have been paid by persons outside incorporated territory, 1921 to 1925.

ROAD UTILIZATION

What relation exists between the mileage of state, county, and township roads and the total traffic on each class of road? Data bearing on this question are sparse. The best available source of information is the Ohio Transport Survey conducted by the Department of Highways and Public Works cooperating with the U. S. Bureau of Public Roads. Tables 2 and 3 are derived from the preliminary report of this transport survey.

Table 2 is based on motor vehicle traffic from December 17, 1924 to December 18, 1925. The state road system representing 13% of the total mileage, carried 57.7% of the total traffic. County roads with 27.1% of the total mileage carried 29.6% of the total traffic. Township roads with 59.9% of the total mileage carried but 13.7% of the total traffic.

TABLE 2.—Motor Vehicle Utilization of Ohio Rural Highways and Highway Mileage by Systems*

Highway system	Miles	Percent of total mileage	Percent of total vehicle miles†	Average daily traffic density
State roads	11,000	13.00	57.70	538
County roads	22,991	27 10	29.60	132
Township roads	50,893	59.90	12.70	26
Total or average	84,884	100.00	100.00	121

*Motor bus traffic not included.
†Vehicle miles are the total miles of travel by all motor vehicles.

ORIGIN OF MOTOR VEHICLE TRAFFIC

Table 3 indicates the percent of motor vehicle traffic, originating in the country or in town, which passes over the state road system. No comparable data are available for county or township roads.

TABLE 3.—Percent of State Road Traffic Originating in Country and in Towns*

Type of vehicle	Traffic originating in		Total
	Country	Towns	
	Pct.	*Pct.*	*Pct.*
Passenger cars	12.40	87.60	100.00
Trucks	15.50	84.50	100.00
Average	13.95	86.05	100.00

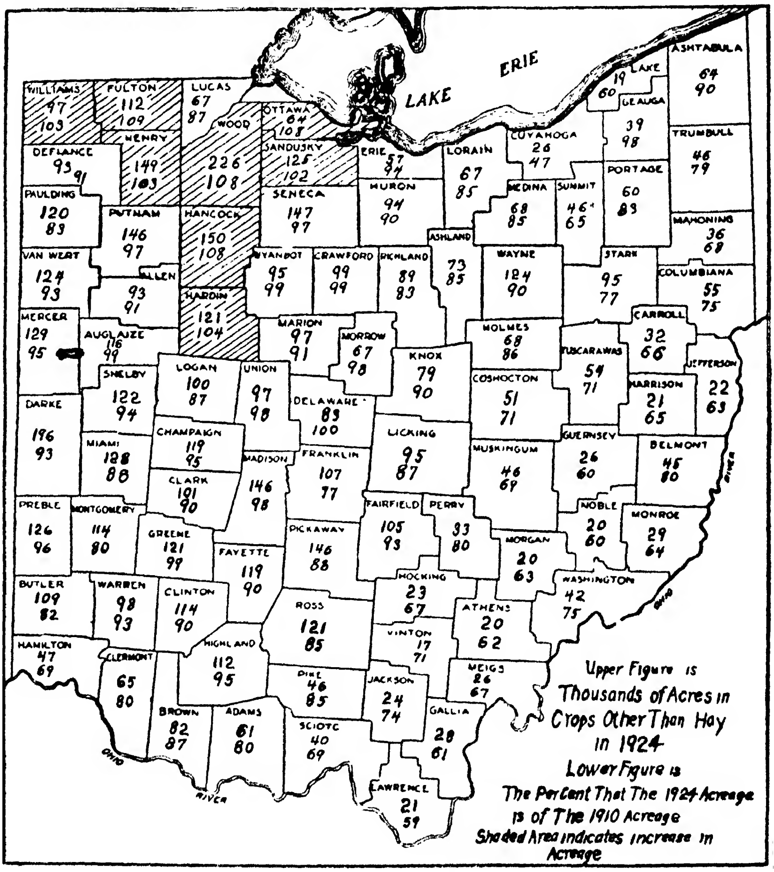
*Horse drawn vehicles not included.

The 86.05% of state road traffic originating in towns is equivalent to 49.65% of the total motor vehicle traffic on all roads in the State. The exact amount of traffic of town origin on county and township roads is largely problematical for no data are available on which to base an estimate. It can hardly be questioned that town-owned vehicles use county and township roads enough to raise the total use of all highways by town-owned vehicles to at least 60 or 65% of the total traffic. Therefore, it is evident that the 72% of Ohio's population that live in incorporated territory supplied considerably more than one-half of the motor vehicle traffic on our highways and contributed approximately one-half of the revenue expended on these highways from 1921 to 1925. The 28% of Ohio's population that live outside incorporated territory supplied less than one-half of the motor vehicle traffic on country roads and contributed an approximate one-half of the revenue.

LAND UTILIZATION IN OHIO

J. I. FALCONER

The shift in acreage of crops other than hay from 1890 to 1924 was shown by counties in the July-August Bimonthly Bulletin. The map in this number shows the shift from 1910 to 1924. The census shows a net decrease of 937,965 acres during this period, or from a total of 8,101,937 acres in 1890 to 7,163,972 acres in 1924. This large indicated decrease is hard to explain. The census figures for 1910 may have been high. The greatest decreases were in the eastern and southeastern counties, while counties with growing cities, show large decreases in crop acreage. Only in northwestern Ohio has the acreage increased since 1910.



Map showing land utilization in 1924 and in 1910

The legend for the map in the July-August Bimonthly Bulletin was inadvertently omitted, but should be the same as that for the map above except that the counties having a decrease in area were shaded.

COMPETITION WITH APPLES IN OHIO MARKETS

CHAS. W. HAUCK

Ohio apples face competition in Ohio markets not only from apples grown in other states but also from certain other fruits and vegetables.

The only available measure of the quantity of fruits and vegetables used in any city in the State is the number of carlots unloaded in that market. This leaves out of consideration the supplies brought in over the highways, of which no complete records are kept. At times these attain large volume. The United States Bureau of Agricultural Economics has estimated that in Cincinnati approximately one-third of the city's fresh fruit and vegetable supply is hauled in by truck or wagon from nearby points.

The carlot unloads of the leading fruits and vegetables in Cincinnati and Cleveland from 1918 to 1926 and in Columbus and Toledo from 1923 to 1926 are presented in Table 1.

Of these 16 commodities, oranges, grapefruit, and grapes doubtless offer the most competition to apples. Their season coincides to a large degree with that of apples. Cantaloupes, peaches, and watermelons, on the contrary, altho unloads are heavy, arrive on the markets in the summer and overlap the apple season only slightly. Among the vegetables, celery, lettuce, and tomatoes compete to some extent with apples, thru their use in salads; they are offered in the markets in quantities during the apple season.

Apple unloads in the four cities during the last three years led all of the fruits, and were exceeded only by potatoes. Oranges, perhaps the greatest single rival of apples, were not far behind. Oranges and grapefruit together reached a total of 4653 cars, or 22% more than the unloads of apples.

TABLE 1.—Carlot Unloads of Fruits and Vegetables in Four Ohio Cities

	Apples	Cabbage	Canta-loupes	Celery	Grape-fruit	Grapes	Lemons	Lettuce	Onions	Oranges	Peaches	Potatoes	Straw-berries	Sweet-potatoes	Toma-toes	Water melons
								Cincinnati								
1918	1130	577	389	145	....	....	....	....	276	....	415	1538	255	....	191	....
1919	1450	557	597	166	....	....	....	....	226	....	631	2047	232	....	202	....
1920	1617	596	554	207	....	....	....	....	283	....	481	2189	80	....	218	....
1921	1810	669	640	316	....	....	....	....	314	....	600	2857	356	368	287	....
1922	1257	781	676	331	....	....	....	....	400	....	609	3447	474	461	438	....
1923	1659	729	461	370	186	603	215	....	394	568	649	2942	559	413	339	486
1924	1531	762	813	382	355	552	308	564	480	1150	762	2698	355	359	345	862
1925	1295	700	678	396	370	551	340	547	453	878	626	3188	340	428	309	686
1926	1179	759	652	335	284	562	341	514	421	842	860	3243	282	481	283	938
3-yr. av. 1924-26	1335	740	714	371	336	555	330	542	451	957	749	3043	326	423	312	829
1918	1192	636	381	120	....	....	....	....	417	....	452	3101	161	....	155	....
1919	1402	503	748	112	....	....	....	....	422	....	584	3135	99	....	170	....
1920	1698	617	657	144	....	....	....	....	593	....	477	3109	138	....	152	....
1921	1184	505	733	243	....	....	....	....	498	....	532	3175	239	....	146	....
1922	1901	576	912	217	....	....	....	....	548	....	850	3506	342	....	271	....
1923	1861	536	749	340	240	1373	192	....	662	847	692	3105	393	606	231	562
1924	1614	732	906	361	578	1789	364	753	745	1631	1146	3499	349	456	305	854
1925	1570	572	1086	356	607	2393	328	865	800	1358	849	2872	260	533	268	824
1926	1754	714	1062	337	489	1294	366	968	781	1612	1162	3669	279	641	299	953
3-yr. av. 1924-26	1646	673	1018	351	558	1825	353	862	775	1534	1052	3347	296	543	291	877

TABLE 1.—Carlot Unloads of Fruits and Vegetables in Four Ohio Cities—Continued

	Apples	Cabbage	Canta-loupes	Celery	Grape-fruit	Grapes	Lemons	Lettuce	Onions	Oranges	Peaches	Potatoes	Straw-berries	Sweet-potatoes	Toma-toes	Water melons
								Columbus								
1923	458	228	200	156	72	193	55	.....	175	215	284	1291	179	230	92	213
1924	549	257	290	195	217	220	123	....	235	485	405	1516	192	201	93	339
1925	439	225	293	208	213	233	111	....	215	442	371	1276	145	234	106	354
1926	580	286	303	176	185	280	143	224	232	552	60[illegible]	1335	154	274	80	351
3-yr. av. 1924-26	523	256	295	193	205	244	126	... .	227	493	459	1376	164	236	93	348
								Toledo								
1923	595	139	125	99	186	171	172	....	251	934	152	1645	150	36	57	134
1924	311	129	107	61	151	335	157	....	88	541	288	1052	170	30	54	154
1925	295	84	109	88	166	77	92	....	145	339	158	467	94	103	41	157
1926	338	154	121	86	133	106	108	167	143	382	231	697	108	161	35	210
3-yr. av. 1924-26	315	122	112	78	150	173	119	....	125	421	226	739	124	98	43	174
3-yr. av. 4 cities	3818	1791	2140	994	1249	2797	927	... .	1579	3404	2486	8504	909	1300	739	2227

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

Since January the price level of farm products advanced, while that of non-agricultural products declined more or less steadily up to July. Since July it has remained fairly constant or even has slightly increased. Farm wages were at least no higher this summer than last and labor was somewhat more available.

Horses are now some 10 percent higher in price than last fall and milch cows can be sold for fully 15 percent above last year's price. Corn prices are reflecting the short crop, while wheat prices are reflecting the influence of the large crop both in this country and in Canada.

The index number of Ohio farm real estate values is a new series. The series previously used was of farm land only, the new series covers farm real estate both land and improvements and should be a more accurate index of the sales prices of Ohio farms. Both series were derived from data of the United States Department of Agriculture.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Non-agricultural products U. S.	Farm products prices U. S.	Ohio Farm wages	Ohio farm real estate	Farm products prices Ohio
1913	102	...	105	100	104	100	104
1914	100	100	97	102	102	102	105
1915	103	101	101	100	103	107	106
1916	100	114	138	117	113	113	121
1917	131	129	182	176	140	119	182
1918	188	160	188	200	175	131	203
1919	290	185	199	209	204	135	218
1920	210	122	241	205	237	159	212
1921	130	203	167	116	164	134	132
1922	152	197	168	124	145	124	127
1923	156	214	171	135	166	122	134
1924	152	218	162	124	165	118	133
1925	161	223	165	146	165	110	159
1926	154	228	161	136	170	105	155
1926							
January	159	229	165	143	160	...	156
February	158	225	164	143	...	105	156
March	154	229	162	140	...	...	155
April	154	227	160	140	167	...	157
May	154	226	160	139	...	...	161
June	155	228	160	139	...	...	161
July	154	227	169	136	176	...	158
August	152	227	160	133	...	...	149
September	154	231	161	134	...	...	149
October	153	231	160	130	177	...	150
November	159	230	161	130	...	...	154
December	150	232	158	127	...	...	151
1927							
January	150	232	155	126	169	...	145
February	149	231	156	127	...	...	145
March	148	234	153	126	...	99	144
April	147	230	151	125	172	...	144
May	147	230	150	126	...	...	145
June	146	230	150	130	...	...	147
July	147	228	151	130	174	...	147
August	149	...	...	...	...	...	149

NEW MONOGRAPH BULLETINS

No. 402, The Forty-fifth Annual Report, by Director C. G. Williams. In one hundred or more short articles, this progress report of the Director states some of the important results or findings of the experimental and research work of the ten departments of the Station. It was mailed to the 70,000 persons whose names are on the Station's mailing list. A limited number of copies are still available.

No. 403, The Timing of Apple Scab Sprays, by H. C. Young and Curtis May. The life cycle of the apple scab fungus is described. The conditions affecting ascospore expulsion are discussed and a method is given for the prediction of the periods of their discharge and infection, just previous to which sprays proved most efficient.

No. 404, Apple Pollination Studies in Ohio, by F. S. Howlett, presents the results of apple pollination studies in the three years, 1924-1926. The larger part of the information is concerned with the fruitfulness of a number of the most important varieties when self-pollinated, their effectiveness as pollinizers, and their fruitfulness as female parents in various crosses.

No. 405, An Experimental Study of Sweet Clover, by C. J. Willard, reports four years of experiments with sweet clover. The most important phase of the study deals with yield and composition of sweet clover at different stages of its growth as compared with other legumes, and when sown under different conditions. Experiments and observations were made and are reported on rate, date, and method of seeding; the agricultural value of the varieties and species; the effect of cutting at different stages of growth; the ratio of tops to roots; the distribution of roots in the soil; and the association of sweet clover with other plants.

No. 406, The Effect of the Use of Salt in Cooking Vegetables, by Faith R. Lanman and Elsie Steiger Minton. The color of vegetables was not changed when pure salt was added at various times of the cooking process. The texture and flavor were improved by adding salt to the cooking water before the vegetables were added or after they were half cooked.

No. 407, Fruit Varieties in Ohio, II, by J. S. Shoemaker. This second bulletin of the series records the behavior of eight fruit varieties that have been under test in the trial grounds of the Experiment Station. They are the Wilma and Salberta peaches, Brassington cherry, Latham red raspberry, Mastodon strawberry, Lucile grape, and Tragedy and Imperial Epineuse plums.

No. 408, Chemical Fertilizers for Greenhouse Lettuce, by J. H. Gourley. The three series of experiments reported in this bulletin were designed to determine to what extent chemical fertilizers, lime, and green manures, without the addition of animal manures, can be relied upon to produce leaf lettuce. Different soils, including subsoil, were used.

No. 409, Market Movements of Livestock in Ohio, by Geo. F. Henning. This bulletin presents information on the movement of Ohio livestock to market, livestock slaughtered by Ohio packers, and on production factors of general interest to livestock farmers. Maps show where Ohio hogs, cattle, and sheep are produced and 24 charts and 45 tables show the disposition made of them.

No. 410, Ringing Applied to the Commercial Orchard, by J. H. Gourley and F. S Howlett. Experiments, extending over five years and including thousands of trees, demonstrated that tardy bearing apple trees can be brought into fruiting by ringing or scoring, without serious injury. The practice is recommended for the special conditions described in the bulletin, such as for filler trees that are slow to come into bearing. The procedure is described and the results of the experiments are given.

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OHIO AGRICULTURAL EXPERIMENT STATION
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THE TREND OF EUROPEAN CORN BORER RESEARCH

L. L. HUBER, D. J. CAFFREY*, AND C. R. NEISWANDER

One of the questions most frequently asked entomologists is, What progress is being made in the control of the European corn borer? It is felt that a brief review of the practical aspects of the research program will not only point out the progress of control methods and the trend of research but will also indicate the emphasis placed on the various phases of investigational work.

By way of introduction it may be said that insect pests are generally fought by one or more of the following methods—namely: by parasites; by insecticides; by certain cultural methods, such as rotations or date of seeding; and by the actual destruction of the insect by some mechanical process. Just what type of defense to be selected for use will depend not only on our knowledge of the habits of the insect but also whether or not the details of the method can be adapted to the behavior of the insect. It is obvious that the only way to learn the habits or behavior of an insect is to live with it, and as information is gained, gradually build up and add to our defensive methods.

MECHANICAL CONTROL METHODS

Of the four types of defense mentioned, that of mechanical destruction seemed to offer the greatest possibility of immediate results. It was generally agreed that the destruction of corn refuse by means of existing farm equipment would result in the death of many borers, but no one knew precisely the efficiency of any one of the several units of equipment and farm practices. It, therefore, became the immediate task of the entomologists to determine the efficiency of each unit of available farm equipment. For example, what percentage of borers perish as the result of plowing under stalks and what kind of plowing is necessary?

During the past few years an accurate check was made on practically every kind of farm implement that could be used in the fight against the borer. We now know that clean plowing holds a high place in any clean farming program. We know too that the shredder and the silo, for example, are efficient in the destruction of borers. However, while a unit may be efficient, we recognize that

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its general use may be limited. Soil conditions may prevent the use of the plow in some areas, and economic factors may prevent an increased use of silos. The point to be made is that, while the entomologists may determine the efficiency of farm equipment and while the agricultural engineers may make this equipment more efficient or even design special machinery, it is left largely to the judgment of the farmer as to whether any particular unit of equipment is practical for him or whether its use can be justified from an economic standpoint.

It may be said unhesitatingly that farm equipment is being employed more advantageously now than it was three years ago. Furthermore, through the efforts of engineers we may hope for a still greater development in mechanical control.

That the employment of regular clean farming practices, such as low cutting, ensiling, plowing, and the like as well as special farm procedure has been of great importance in keeping infestation lower than it would have been, is scarcely to be doubted. Just how much of our presumed control, however, is due to clean farming is still an unanswered question. The fact that investigational work along the lines of parasite introduction, insecticides, and cultural practices is being vigorously prosecuted is evidence enough that entomologists are giving more than passing consideration to some of the observed habits of the borer and are not by any means assuming that clean farming alone will be the ultimate solution of the problem in all areas.

PARASITES

With the initiation of the investigational work upon the European corn borer in 1918, a very keen interest was displayed in the possibility of a measure of control by natural enemies of the pest, particularly by its insect parasites. Great emphasis has been placed, therefore, on this phase of the research activities. The program for the future involves a continuance of the present exhaustive investigation, having for its principal objective a determination of the possibilities of native and imported parasites as aids in controlling the borer.

IMPORTED PARASITES

Since observation of the native insect parasites of the corn borer soon demonstrated that under natural conditions the native species were of little consequence as natural checks upon the pest, the next logical step was to consider the importation of insect parasites of the corn borer from Europe, particularly from France, Italy, Belgium, and Hungary.

Investigations begun in Europe by the U. S. Bureau of Entomology in 1919, soon after the corn borer was discovered in the United States, revealed several species of parasites that were important aids in the natural control of the species in localized areas. Continued research has shown that, during the period covered by the investigations, the insect parasites alone have not been effective in controlling the borer in any area under observation, although their beneficial activities have constituted an important aid in certain regions.

However, it must be remembered that in Europe these selfsame parasites are in turn beset by other parasites. In the work of parasite introduction, particular care is taken not to introduce the parasites of the parasites—the so-called hyperparasites. It may develop that the parasites thus introduced may be more effective in America than they are at home. Whether the normal cycles of abundance and the reverse, with relation to the parasites and their host, will reveal a more important role on the part of the parasites in Europe than now appears evident, must await the results of further observation and study.

The survey of corn borer parasite possibilities abroad has been extended to include the known areas of distribution of the corn borer in the Orient, particularly in Japan, China, and India. Preliminary importations of parasites have been received in the United States from Japan and India and it is proposed to continue the field research studies in that section of the world, following the methods now practiced in Europe, until the availability of parasite aid has been thoroughly investigated.

IMPORTATION OF PARASITES FROM EUROPE

After laboratory and field studies in Europe had indicated the parasite species of greatest potential value, with due regard to their biology, probable economic status, and relation to other parasite species, the selected species were sent to the United States and liberated in corn-borer infested fields, at strategic points. From early in 1920 until November 15, 1927, nearly 400,000 foreign parasites of the corn borer were imported from Europe by investigators of the U. S. Bureau of Entomology. Twelve different species were included in these shipments. It may be said in passing that six of these species have been recovered under circumstances that seem to show that they have permanently established themselves.

Since 1921 the laboratory breeding operations have been conducted on an extensive scale. This activity resulted in the breed-

ing of more than 1,700,000 parasites, to November 15, 1927, which were added to the number liberated in the field from direct importations.

A large proportion of the parasite adults secured by importation were liberated directly in the field. The remainder of these adults have been utilized as breeding stock in laboratory operations to secure a rapid multiplication of the parasites for ultimate liberation in the field.

Up to date a total of approximately 2,000,000 imported parasites, representing twelve different species, have been imported, bred, and liberated in the infested fields of the United States.

STATUS OF PARASITES WITH RELATION TO CONTROL

Although every effort will be continued, and intensified where necessary, to import, breed, and establish promising insect parasites of the corn borer in American areas infested by the corn borer, a discussion of the research activities in connection with these imported parasites would be incomplete without emphasizing the point that it is by no means certain they will prove to be effective aids in controlling the pest. Judging from the history of similar parasite importation activities to aid in the fight against other foreign plant pests, several years may elapse, even with the best of success, before any important effect can be expected. In the meantime every effort should be made to control the corn borer, or limit its economic damage, by the methods discussed in other portions of this article.

INSECTICIDES

In all experiments thus far the application of insecticides invariably has proved either ineffective or impractical from the cost standpoint in protecting growing corn from injury by the European corn borer, although this method of attack has been successful in destroying large numbers of the borers in the early stages.

While it has been appreciated that the cost of applying any known insecticide to the main crop of field or sweet corn would probably prove prohibitive under field conditions, it has appeared desirable to attempt the development of methods which would be effective, with the thought that the cost of such applications, providing they were successful, ultimately could be reduced to a point where it would be practical to apply them to the main crop of corn.

The choice of the insecticides employed, and the method and time of their application have, of course, been based upon careful

studies of the detailed behavior of the insect as well as upon the known facts concerning the chemical and physical properties of the insecticides used and the physiology of the plant and of the corn borer. That the results, in general, have been negative up to the present time should not discourage us from continuing to seek remedial measures of relief through the medium of insecticides. With this thought in mind the possibility of developing more effective insecticides for the corn borer is still under investigation.

The more important insecticides which have been tested or are now under investigation include the following substances employed alone, or in various combinations, as a dust or as a spray: lead arsenate (several forms), calcium arsenate, magnesium arsenate, nicotine dusts, nicotine sulphate, sulphur, nitrobenzol, calcium fluosilicate, sodium fluosilicate, derris, paraffin oil, calcium cyanide, silico-fluorides, hydrated lime, and various special patented preparations.

It is apparent that, while none of the insecticidal materials or methods tested to date can be recommended for practical use in combating the corn borer, the results secured and the objectives sought are of sufficient value and importance to warrant a continuance of the experiments now under way and an intensification of the effort to develop effective insecticides.

CULTURAL PRACTICES

One of the most important responses of the corn borer to its environment is its response to time of planting corn. Planting later than normal automatically reduces potential infestation and consequent damage. Other things being equal, it follows without exception that the later corn is planted the fewer borers it will contain. It is evident that the condition of the corn, whether good or poor, early or late, is a factor of very great importance in the decrease or increase of the borer in any area. It would seem then that if we could modify the environment by planting corn at a later date we would thereby escape appreciable commercial loss. In this connection it should also be mentioned that some varieties are more tolerant than others, and that there is a difference in larval establishment on some varieties. In no case thus far, however, has any variety proved free from attack or immune.

CONCLUSIONS

From the standpoint of entomological research and experimental work it may be concluded that although neither parasites nor insecticides offer much hope of immediate relief, yet they are the subjects of exhaustive research. Furthermore, investigations along the line of cultural practices have been sufficiently promising to warrant a trial or later planting when and where necessary but always in conjunction with or supplementary to the clean farming practices of the present. In addition to the entomological recommendations there are the further possibilities that the agronomists by their researches will ultimately provide varieties better adapted to corn borer conditions and the engineers through their investigations will facilitate and improve clean farming operations. It would seem, therefore, that sufficient progress has been made to warrant the belief that through continued efforts in all the practical phases of research we will ultimately learn how to grow corn profitably despite the borer.

SOIL TYPE INFLUENCES EUROPEAN CORN BORER ACCUMULATION

C. R. NEISWANDER, G. W. CONREY, AND L. L. HUBER

Any discussion of the European corn borer immediately involves a consideration of the corn plant, for the conditions in general which influence the behavior of the insect also influence the growth of corn. Thus climate which limits the areas where corn can be grown best also in large measure may be expected to limit the areas most acceptable to the borer. However, over an area where fairly uniform climatic conditions prevail or where climate is not the limiting factor in corn production or corn borer accumulation, soil conditions may influence the behavior of the corn plant and, therefore, indirectly influence the habits of the corn borer or modify the relationship between the two. It is the indirect influence of soil conditions and soil types on corn borer accumulation that will be discussed in this article.

Investigations since 1923 have demonstrated that the corn borer has shown and is still showing a tendency to accumulate more

rapidly in some areas than in others. Thus far, in Ohio and neighboring states, the corn borer has done no commercial damage except in those areas where corn grows best, or where the soil is fertile.

Since the beginning of corn borer investigations in Ohio the insect has been studied in relation to the development of corn as indicated by the rate of growth and the time of tasseling or silking. It appears that the nature of the response of the corn borer moths to corn depends largely upon the stage of development attained by the plant at the time the moths are depositing their eggs. Any conditions, therefore, which influence the development of corn will indirectly influence the degree of infestation by the insect. Early investigations merely indicated that corn growing most luxuriantly during the period of moth flight ultimately carried the heaviest infestation. These observations became so well established that fields having a high or low infestation could be differentiated by the external appearance of the crop as a whole without examination of the plants. For example, the infestation of the corn on the lowlands of Lake County was always high while that of the corn on the uplands was always low and the corn on the lowlands was generally good while that on the uplands was generally poor. Analysis of the conditions causing differences in the rate of infestation of corn grown in the areas naturally led to a consideration of the variations in the fertility of the soil.

The general observations of the relation of soil fertility to the corn borer problem indicated the need of more specific information relative to soil types. Through the cooperation of soil survey officials of the United States Department of Agriculture an intensive study of the soils of the most heavily infested areas in Ohio was begun this year. It was made possible for the soil surveyors and entomologists working together to map the soil types and record the percentage of infestation and borer population of representative fields within each type. The discussion below is based on the results of the examination of 350 fields.

The area of heaviest infestation in Ohio at this time is confined to the "Lake plain" bordering Lake Erie. This is a very narrow belt in northeastern Ohio, while in the northwestern part of the State it covers a broad area extending into Indiana. The soils vary in texture from sand to heavy clay, and range in color from light to dark, the latter due to differences in content of organic matter. Color correlates closely with conditions of natural drainage, the light colored soils being for the most part naturally well drained and well aerated, and the dark colored soils naturally poorly drained.

Many of the areas of poorly drained soils have been more or less thoroughly drained by tiling. In the case of some light colored clay soils the natural drainage is also poor. In the western part of the "Lake plain" the soils have been derived largely from calcareous material, while in northeastern Ohio the parent material is largely noncalcareous sandstone and shale.

In eastern Lucas County, east of Toledo, the area of greatest infestation in Ohio at the present time, the soil is fairly uniform, consisting of a dark colored silty clay (Toledo silty clay) with scattered, more or less irregular light colored areas (Fulton silty clay loam). In field corn the highest infestation is now and has been for the most part on areas of Toledo silty clay, and moreover the infestation is fairly uniform over the fields. Most of the corn fields are of this type, but many include some of the light colored soil (Fulton silty clay loam), on which the corn invariably is poorer and the infestation less than on the dark soil. For example, one field showed a 12 percent infestation on the light colored soil, 38 percent on the gradation soil, and 86 percent on the dark soil. The corn was poor, average, and good on the three sites. This particular observation is substantiated by the records of the previous three years.

In western Lucas County most of the sweet corn examined was grown on light and dark fine sands and fine sandy loams, many of the fields including both light and dark soils. The infestation in the majority of cases was between 25 and 30 percent. Even on the light sand where the land had been properly fertilized so that the corn was good, the infestation was within the same range. Commonly, however, the corn is rather poor on the deep, light colored sands of the region, and coincidentally the infestation is low. In this same area field corn showed a much lower infestation, averaging about 10 percent. Most of it was grown on heavier soils than was the sweet corn.

Nowhere in northwestern Ohio in areas of glacial limestone soils to the south of the of the "Lake plain" has the infestation as yet reached such proportions as to give an opportunity for studying the soil relationships.

Lake County, east of Cleveland, is representative of northeastern Ohio. Here there is a narrow belt of "Lake plain" soils, and also a considerable area of glacial sandstone and shale soils.

Sweet corn has shown high infestation. This year twelve fields averaged 54 percent with three above 80 percent. Practically all of this corn was grown on fine, sandy loam soils within the "Lake

plain", especially on the gravelly beach ridges. Field corn on sandy soils within the "Lake plain" showed an average of 44 percent in three fields examined.

The upland or glacial sandstone and shale soils (Mahoning silty clay loam, Volusia silty clay loam, and others) in the southern part of Lake County have always shown a low infestation. A part of the explanation for this low infestation lies in the fact that these soils are not well adapted to corn and, therefore, the corn is usually very late. Moreover climatic conditions a short distance back from the Lake are very unfavorable for this crop. The soil and climatic conditions characteristic of the region northeast of Cleveland and back from the Lake, result in late corn of only fair quality. Although the corn borer has been in this region as long as in northwestern Ohio, the infestation has been very low on the heavy light colored soils that characterize the region south of the "Lake plain."

An exception to this was noted in the case of the gravelly terraces (Chenango loam and silt loam) and river flood plains (Chagrin silt loam). These soils are earlier and more fertile than the average upland soil in this region (northeastern Ohio) and grow fairly good corn, which in average years matures earlier than on the upland. In such sites the infestation has been higher than on the upland.

CONCLUSIONS

1. Investigations have shown that, other factors being equal, the rate of development of the corn plant is largely dependent upon soil fertility, or the ability of the soil to produce good corn. Furthermore it has been shown that the stage of development attained by the corn plant at the period of moth flight greatly influences subsequent infestation. The corn borer has, therefore, shown a tendency to accumulate most rapidly in areas which habitually produce good corn or where the soil is fertile.

2. Eastern Ohio should have a less serious corn borer problem than western Ohio because it habitually produces poorer corn than western Ohio. Moreover similar areas, such as fields or parts of fields of corn, even though situated in a region highly susceptible to corn borer accumulation may have but few borers if soil conditions are such as to prevent vigorous growth and early development of corn.

3. In western Ohio and adjoining regions the best corn soils are chiefly the Brookston silty clay loam and Clyde silty clay loam in the glacial limestone area, and Brookston clay and Toledo silty

clay within the "Lake plain". These are the dark colored soils of the area and are naturally poorly drained. Artificial drainage has been required for their utilization.

4. Next to the dark soils will probably be the well drained, light colored soils which in the glacial limestone area include chiefly the Bellefontaine and Miami silt loams. In the "Lake plain" the well drained light colored soils include the Lucas and beach ridge phase of the Fox soils, chiefly fine sandy loams and loams. The gravelly terraces—Fox loam and silt loam should be included in this group. These are fertile soils and produce good corn.

5. The poorly drained light colored soils such as the Crosby, Napanee, and Fulton are fair to poor corn soils and, have shown a lower infestation than any of those already mentioned.

6. The heavy light colored glacial soils from sandstone and shale, such as occur in northeastern Ohio and adjacent parts of Pennsylvania and New York (Mahoning, Ellsworth, Volusia, etc.), can be classed as fair to poor corn soils. To date there has been a slight infestation only in corn grown on them. The climatic factor is important resulting in very late corn in this region, most of which is used for ensilage. Heavy infestation has been observed in corn on the gravelly terraces, (Chenango loam and silt loam) and on the flood plain soils (Chagrin silt loam and Papakating silty clay loam.) Dark soils throughout the upland (Chippewa silty clay loam) are very limited in extent and unimporant, but show a higher infestation than the associated light colored soils.

HAY FOR DAIRY CATTLE

C. C. HAYDEN

For many years dairy specialists have been advocating the liberal use of legume hays for dairy cows and have been urging dairymen to grow them where possible. Recent investigations at several experiment stations have shown that legumes are even more valuable than formerly believed, because of the minerals and vitamins contained. The quality of these hays has much to do with their mineral and vitamin content, early-cut, well-cured, high quality hays being greatly superior to those cut later or of lower or medium quality. The vitamin content of the hay may materially affect the vitamin content of the milk produced.

The difficulties which the Ohio Experiment Station has encountered in securing hay of the desired quality leads to the belief that dairymen who cannot grow their legume hay may have similar difficulties. Due to the common lack of a proper understanding as to grades, differences of opinion may easily arise; hay considered choice by one man may not be so considered by another.

The grade of hay should be specified clearly in the order. This can be done if the buyer knows the requirements of the different grades so as to describe them properly.

Alfalfa hay is richer in protein and vitamins than other hay and, therefore, is more commonly sought by dairymen who can not produce it on their own farms. Hay bought in the large western markets can be ordered by U. S. grade with reasonable certainty of securing the grade desired, if inspection is demanded.

A considerable amount of good alfalfa is produced in western Ohio, but not a large amount of it is cured into the fancy grades. Some of it is shipped south. If this hay were fed in Ohio it would save the high freight rates from the western markets. Government inspection can not be secured in Ohio, unless in the Cincinnati market, therefore one needs to use care in ordering.

The Bureau of Agricultural Economics at Washington gives a description of the grades best suited to dairy purposes. It is well to keep in mind that grade No. 1 must not contain more than 5 percent of foreign matter, and No. 2 not more than 10 percent.

The U. S. grades of alfalfa that are best suited to dairy feeding are:

U. S. No. 1 Extra Leafy Alfalfa
U. S. No. 1 Extra Green Alfalfa
U. S. No. 1 Alfalfa
U. S. No. 2 Extra Leafy Alfalfa
U. S. No. 2 Leafy Alfalfa

U. S. No. 1 EXTRA LEAFY ALFALFA. Hay of this special grade is unusually leafy with most of the leaves clinging. Fifty percent of the hay must consist of leaves, or 10 percent more leaves than the requirement for straight U. S. No. 1 Alfalfa. The color and foreign material requirements are the same as for the No. 1 grade. This fancy hay is made by properly curing alfalfa cut in the bud or early bloom stage or not later than from 1/10 to ¼ bloom. In nonirrigated sections it is usually a product of the last cutting of the season made in the autumn. Alfalfa that meets the specifications of this special grade is soft-stemmed, with clinging foliage, and has a relatively high percentage of protein. Not more than 3 to 5 percent of the alfalfa crop will meet the requirements of this grade.

U. S. No. 1 EXTRA GREEN ALFALFA. Hay of this special grade is exceptionally green. It must have 15 percent more green color than the minimum color required for the U. S. No. 1 grade. The leafy and foreign material requirements are the same as for U. S. No. 1. Hay of this special grade is produced usually under irrigation at

high altitudes and is a very pronounced "pea green" hay. Dairy experts claim that the feeding of extra green alfalfa favorably affects the production of the highly desirable yellow color in milk. Extra green alfalfa, also, indicates a high vitamin content as well as a high percentage of the delicate, easily soluble and easily digested feed nutrients.

U. S. No. 1 ALFALFA is leafy, green hay, very suitable for dairy purposes. During the cutting, curing, and baling processes, hay of this grade must retain at least 40 percent of its leaves and in addition it must be 60 percent green. In order to be 60 percent green according to the U. S. standards the hay must be cured in such a way as to have received very little or no discoloration from heavy dews, rains, excess sun bleach, or sweating. U. S. No. 1 Alfalfa is meeting with much favor as a dairy hay although it is not as fancy a type of hay as U. S. No. 1 Extra Leafy or U. S. No. 1 Extra Green. During average years from ⅕ to ¼ of the alfalfa crop in the important alfalfa shipping States will meet the specifications for this grade and this grade normally sells at lower prices than such fancy grades as U. S. No. 1 Extra Leafy Alfalfa.

U. S. No. 2 EXTRA LEAFY ALFALFA. Hay of this special grade is unusually leafy with most of the leaves clinging. The only difference between this grade and U. S. No. 1 Extra Leafy Alfalfa is in the color requirement, which is lower for this grade and which permits moderate discolorations from heavy dews, showers, or fogs. Dairymen who desire strictly green alfalfa would not be as well satisfied with this grade as with the special grade U. S. No. 1 Extra Leafy Alfalfa, which has more green color.

U. S. No. 2 LEAFY ALFALFA. Hay of this grade is just as leafy and pure as U. S. No. 1 Alfalfa but it has less green color because of the discolorations from heavy dews, showers, or fogs. Hay of this grade is being used extensively as a dairy feed but dairymen who desire strictly green alfalfa would not be as well satisfied with this grade as with U. S. No. 1 Alfalfa. It should be remembered, however, that the leaves contain approximately 70 percent of the protein of alfalfa hay and that this grade is a leafy type of alfalfa which is produced in greater quantity than the fancier grades and can be obtained usually at lower prices.

Additional information about U. S. hay standards, Federal hay inspection, Hay Market News and hay supplies, may be obtained from Federal Inspection Supervisors at the following addresses:

W. M. King, Hay, Feed and Seed Division, Bureau of Agricultural Economics, Washington, D. C.

H. H. Whiteside, Room 1209, 139 N. Clark Street, Chicago, Ill.

Description of similar grades of other kinds of hay may be obtained from the Bureau of Agricultural Economics, Washington, D. C.

Dairymen will do well to inspect thoroughly each car before hauling any of it away. Recently the Station ordered two cars of No. 1 clover. One car contained No. 1 clover between the doors, but the remainder was nearly 75 percent timothy, some bales being nearly pure timothy. Difficulties such as this may be avoided if there is a proper agreement with the shipper as to quality as well as price.

INHERITANCE OF SCROTAL HERNIA IN SWINE

B. L. WARWICK

Hernias or ruptures of swine are so common that scarcely a swine raiser has escaped experience with them. The two most common kinds are scrotal and umbilical or navel. Scrotal hernia consists of an enlargement of the scrotum by loops of bowel. These pass through the opening of the abdominal wall with the spermatic cord which connects with the testicle. Umbilical or navel hernia is formed by loops of bowel passing through the abdominal wall at the umbilicus or navel, but without a break in the skin.

Fig. 1.—Scrotal hernia of a mature boar

This boar was used in breeding experiments to determine the mode of inheritance of scrotal hernia.

In a study of the occurrence of hernias in swine it was found by the writer (Wisconsin Research Bulletin 69) that 1.73 percent of all pigs raised had hernias. Of the male pigs raised 1.68 percent had scrotal and 0.60 percent had umbilical or navel hernias. Among

the female pigs of the same herds, 1.16 percent were ruptured. Practically all of these had umbilical, although a few had inguinal, hernias. This last kind of hernia corresponds in location to the scrotal hernia in the male.

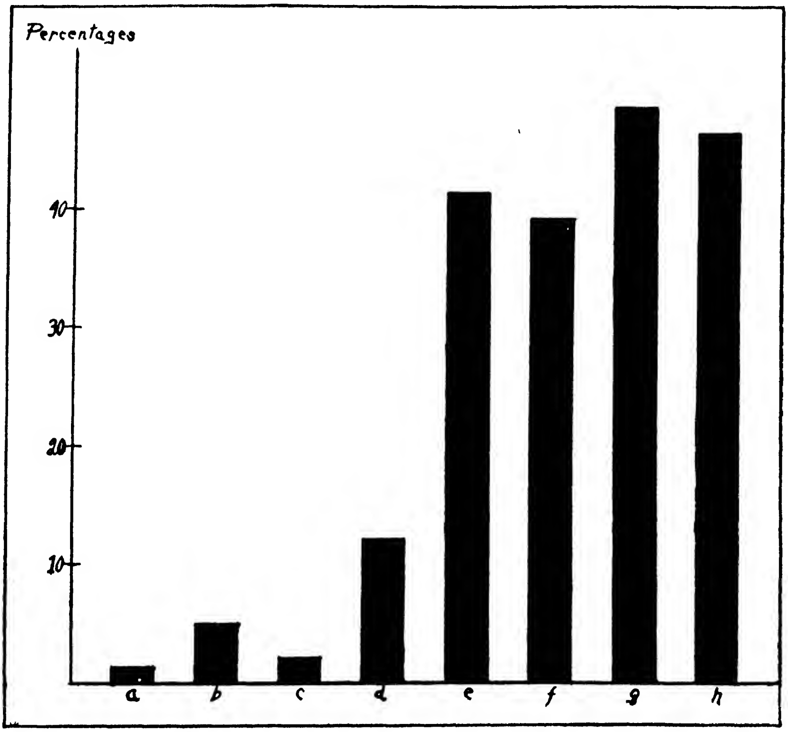


Fig. 2.—Scrotal hernia in swine

a. Experiment Station herds, no selection except elimination of herniates.
b. Parent herd, first period, no selection except elimination of herniates.
c. Parent herd, second period, after eliminating two boars.
d. First generation selection for hernia.
e. Second generation selection for hernia.
f. Third generation selection for hernia.
g. Fourth generation selection for hernia.
h. Fifth generation selection for hernia.

In breeding experiments initiated at the Wisconsin Agricultural Experiment Station and being continued at the Ohio Agricultural Experiment Station, the writer has found that scrotal hernia of swine is definitely heritable. Umbilical or navel hernia is also being studied, but the breeding is not far enough advanced to draw any conclusions as to whether inherited or not. The fifth generation of pigs bred for scrotal hernia has been raised. The parent

stock included only boars with scrotal hernias, while the females were selected, as far as possible, for close relationship to herniated boars. The herd from which the parents were selected showed 7.49 percent of the male pigs ruptured in the spring farrowing season immediately preceding the selection, and 4.19 percent during three years of observation. The first generation of breeding for hernia resulted in 14.28 percent of the male pigs being ruptured. The second generation had 42.0 percent, the third generation 39.4 percent, the fourth generation 47.5 percent, and the fifth generation 45.9 percent of the male pigs with scrotal hernias.

These figures clearly show that a tendency to scrotal hernia is inherited. The mode of inheritance has not yet been definitely established, but certainly is recessive in nature. A two-factor hypothesis is being used as a working basis. In order to study this further, females which will breed true for scrotal ruptures when bred to ruptured boars should be found by test. Further breeding tests with these pure stocks would help to establish the true mode of inheritance. Three sows have now been found in the stock which have bred true so far as tested and are being tested further.

While a complete analysis of scrotal rupture has not yet been reached, basic principles enough have been established to serve as a guide toward its eradication, or at least its reduction to a negligible point. In the light of the experimental work which has been done, the following procedures should aid greatly in its elimination.

1. No boar should be used which is or ever has been afflicted with scrotal hernia. This includes animals in which the rupture has disappeared naturally, as well as operated animals. Whether hernias would appear among the immediate offspring of any such boar would depend upon the hereditary makeup of the females with which he was mated. In any case all of his offspring would carry some of the factors responsible for scrotal hernia. This would make it very probable that ruptures would appear in later generations whenever individuals of certain hereditary makeup (even though themselves normal) happened to be mated together.

2. Any normal boar which has sired one or more ruptured pigs should be discarded. Such a boar will transmit factors for scrotal hernia to more than half his offspring and hence tend to carry it on in the herd, even though the sows to which he is mated should be entirely free from the taint.

3. Breeding stock should not be selected from sows which have produced one or more scrotally ruptured pigs. The same reasons apply here as in the case of the male.

4. Litter mates to scrotally ruptured boars should not be retained for breeding purposes, especially the males. Some of these will probably be free from the hernia factors, but it would require extensive breeding tests to determine which ones these are.

5. Elimination of all of the progeny of boars which have been known to sire scrotally ruptured pigs would also be advised where especial effort is being made to eliminate scrotal hernia.

The rules which have been suggested provide a logical method of reducing and in time of entirely eliminating scrotal hernia from a herd of swine. It may be more drastic than would be practical in some cases, especially as there is always danger of reintroducing the defect whenever new animals from outside are brought in. Since the boar is the parent of many more offspring than any one sow, his influence on the breeding of the herd is far greater than that of any individual female. For this reason it is especially desirable to take care in his selection.

SHEEP BREEDING

Geneticist starts experiments to eliminate black sheep from every flock

WEEKLY PRESS BULLETIN

A very interesting flock of sheep has been collected at the Ohio Experiment Station, by B. L. Warwick, in charge of animal genetic investigations, for the purpose of experimental breeding to eliminate undesirable characters.

Among the undesirable characters now represented in the flock and to be eliminated by breeding are black fleece, black fiber mixed in white fleece, "chalk-face" and other undesirable fibers, cryptorchidism or undescended testicles commonly known as ridglings, and turned-in eyelids.

About one hundred head, have been placed in the experimental flock during the last year.

Tests in breeding to get rid of these characters are being carried out to learn the best breeding procedure for their elimination.

The inheritance of wrinkling of the different Merino types is being investigated with special reference to the relationship of wrinkling to fleece characters. An attempt is also being made to breed a strain of sheep by selection that will be resistant to stomach worms.

Breeding experiments with other characters, such as horns, twinning, earliness of breeding, and rapidity of growth will be started by Dr. Warwick as soon as facilities permit.

FORMALDEHYDE AND IODINE DUSTS FOR THE CONTROL OF OAT SMUT

J. D. SAYRE AND R. C. THOMAS

That the smuts of oats can be controlled by dust treatment, was shown very clearly in Bulletin 390 and the Bimonthly Bulletin, Jan.-Feb., 1926, of the Ohio Station. Corrosive sublimate combined, respectively, with such copper or nickel compounds as the sulphate, acetate, or carbonate, afforded commercial control of the smut, yet possessed one disadvantage. They were too expensive. Even corrosive sublimate and copper sulphate the least expensive combination, could not be prepared for less than $1.50 per pound, rendering the cost of treatment from 10 to 15 cents per bushel

In the original formulas the dusts were prepared by thoroughly mixing two parts by weight of finely ground corrosive sublimate with one part of a copper or nickel salt. We were much disappointed to find in later trials that, under Ohio conditions, any variation from the orginal formulas involving a reduction in the proportion of the mercury salt and a corresponding increase in the copper or nickel in every case resulted in a loss of control. Likewise, when inexpensive inert fillers were used to adulterate any of the original preparations, control of the smut was not obtained. The same was true when the different copper and mercury salts were used alone.

In 1926 further variations were introduced with the end in view of lowering the cost of treatment and still maintaining the high efficiency of smut control. In both respects we were successful as indicated in Table 1.

TABLE 1.—Oat Smut Control Tests of 1926

	Preparation	Smut
		Pct.
	Check, not treated	19.00
1	Colloidal copper	6.6
2	Wa Wa dust	0.004
3*	Mercuric chloride, 2 parts; Copper sulphate, 1 part	trace
4*	Mercuric chloride, Cresylic acid, Copper sulphate — equal parts	0
5*	Mercuric chloride, Phenol, Copper sulphate — equal parts	0.9

*Formulas suggested by Dr. H. C. Young.

The mercuric-chloride—cresylic-acid—copper-sulphate mixture afforded perfect smut control. With phenol or carbolic acid substituted for the cresylic acid in another series of plots less than one percent of smut was found. While the cost of these preparations was about half that of the original formulas, they were still considered too high in price for general recommendation, although very satisfactory for disease reduction and ease of application. Wa Wa dust, a commercial preparation, has always given excellent insurance against smut, but it is open to the same objection regarding cost, as our own products.

In our tests of this year it seemed advisable to discard the mercury and copper combinations because there was little probability of reducing the cost further and still mantaining fungicidal efficiency. Formaldehyde, in the liquid or so-called dry forms, has long been recommended for grain treatment. Its effectiveness is unquestioned, yet it has not gained general favor in Ohio, because there is a reluctance regarding the use of any form of wet treatment for grains, and also there have been many instances of serious injury to germination. Formaldehyde is a gas in solution, it is cheap and, in many respects, is an ideal fungicide. The gas is readily volatile and is effective only during the short period that it is being liberated. After the gas escapes no undesirable residual deposits are left.

Because of the gaseous and volatile nature of the substance, it was thought probable that it could be adapted for use in the dust form, also when used as a dust that it would be less likely to produce seed injury, than in the liquid form of treatment. The dusts were prepared by first mixing equal parts by weight of 40-percent formaldehyde with either charcoal finely ground or infusorial earth. This concentration was much too expensive for practical use and was therefore made the basis from which the different dilutions were made. In these tests dusts containing 3.3 percent, 6 percent and 9 percent of formaldehyde actually present in a solution of 40-percent commercial formaldehyde were prepared.

Another new treatment, iodine dust, was used in the same test with excellent results. This dust was made by mixing finely ground solid iodine with infusorial earth. The iodine vaporizes readly at ordinary temperatures, diffuses through the infusorial earth, giving it a light yellow-ochre color. This dust contained 5 percent by weight of iodine. Since both iodine and formaldehyde are volatile substances, the dusts, after preparation, must be kept in air-tight containers, preferably glass, if it is necessary to keep them for a considerable period before use.

Only one concentration of the iodine dust was used in this work. There is some evidence that a dust containing less than 5 percent may be equally effective. Further tests will be necessary to verify this, however. Dust containing as low a concentration as 3.3 percent of formaldehyde gave excellent control of oat smuts, except in one instance where less than 1 percent was recorded.

TABLE 2.—Oat Smut Control, 1927

Treatments	Smut
	Pct.
Checks, average of 12	47
Formaldehyde, 8.2 percent, in charcoal	Trace*
Formaldehyde, 5.6 percent, in charcoal	Trace
Formaldehyde, 3.3 percent, in charcoal	Trace
Formaldehyde, 9.3 percent, in infusorial earth	Trace
Formaldehyde, 6.0 percent, in infusorial earth	Trace
Formaldehyde, 3.7 percent, in infusorial earth	Trace
Wet formaldehyde (1-10)	Trace
Iodine, 5 percent, in infusorial earth	None
Formaldehyde, 3.3 percent, in infusorial earth	Less than 1 percent
Formaldehyde, 5.6 percent, in infusorial earth	Trace

*Less than one-half of one percent.

It would seem that a concentration of about 4 percent formaldehyde should be satisfactory.

The cost of the formaldehyde and iodine dusts is much lower than any of the preparations previously reported that gave equally satisfactory control. Each of the two dusts was used at the rate of 3 ounces per bushel. It is estimated that grain may be treated for about 5 cents per bushel with either of them. When methods of use and exact concentrations have been more fully determined, it is hoped that these preparations will prove a cheap, efficient dust for the control of oat smut.

POTATO DUSTING AND SPRAYING IN 1927

PAUL E. TILFORD

Since many of the potato growers of the State have urged that the results of spraying and dusting experiments be made available as soon as possible, it seems best to publish those for 1927 in brief form at this time. The results for 1924 and 1925 were published in the Bimonthly Bulletin of the Station for January-February, 1925, and July-August, 1926, respectively, and those for 1926 in the 45th Annual Report of the Experiment Station.

The experiment in 1927 was conducted in much the same manner as those of previous years. The plots were 1/100 acre in size and each treatment was repeated three times. Check plots were distributed through the series so that each treated plot was adjacent to a check plot.

The sprays were applied with a high pressure power sprayer. An orchard sprayer was used for the last three applications. By the use of a spray gun and a 50-foot hose, it was possible to spray the vines thoroughly without driving through the plots. This eliminated the possibility of injuring the vines in the sprayed plots and of giving the dusted plots an advantage, since the dusts were always applied with a hand duster.

The average application per acre for the various dusts was between 40 and 45 pounds. In the case of sprays, the first five applications were approximately 100 gallons per acre, while the last three were increased to at least 150 gallons per acre. The potatoes were planted May 27 and were treated first on June 30. The second treatment was on July 14 and from then on successive treatments were applied at weekly or ten-day intervals throughout the summer. In all, eight applications were made, except in the case of the plots which received only four treatments. Dusts and sprays were applied on the same day when possible and never more than two days apart. The dusts were always applied in the morning when the plants were wet with dew.

The potatoes were dug in October. The average yields per acre and increases over checks are given in Table 1.

TABLE 1.—Potato Yields and Increases Due to Spraying and Dusting

Treatment	Yield per acre	Increase over comparable checks
	Bu.	*Bu.*
4-6-50 bordeaux	372.7	124.7
5-5-50 bordeaux	363.8	113.4
4-4-50 bordeaux	355.5	109.1
Dust 20-40-40 (Kaolin) fresh mixed	353.8	106.8
Dust General Chemical 9-50	351.0	106.7
Bodo (commercial bordeaux)	352.2	105.5
Dust 20-80 fresh mixed	347.7	103.2
Dust General Chemical 9-10	338.8	90.9
Dust Niagara D 6	333.2	83.5
5-5-50 bordeaux 4 applications	227.6	79.7
Dust Niagara experimental	312.8	69.5

A fresh lot of high grade hydrated lime was used in the preparation of the 4-6-50 bordeaux, while stone lime was used in the preparation of the other home-made bordeaux sprays. The commercial bordeaux (Bodo) was furnished by the Bowker Chemical

Company. The 20-80 dust was a mixture of monohydrated copper sulfate and hydrated lime in the ratio of 20 parts of copper sulfate to 80 parts of hydrated lime. The materials were mixed immediately before using. The 20-40-40 dust was a fresh mixed experimental dust in which 40 parts of the lime was replaced by Kaolin, which is an inactive material and was used as a filler. Both of the General Chemical dusts are experimental products, neither of which is on the market at the present time.

Few comments on the results are necessary since they speak clearly for themselves. Very little late blight was evident in the check plots early in September. It did not appear in any of the treated plots, however, to the extent that data could be obtained to show the relative efficiency of the treatments in the control of blight. In fact, it was not severe enough in the check plots to cause any rotting of tubers. It should be explained that hopperburn was the only disease of any consequence in any of the plots, and the increases reported must be considered as due to the control of hopperburn.

A field experiment was conducted on the farm of A. C. Ramseyer, Smithville, Ohio. In this test the spray was a 5-7½-50 bordeaux, applied in a very thorough manner. The dust used was a 20-80 fresh mixed copper-lime, applied with a power duster. Seven applications of each dust and spray were made during the summer. The results obtained were as follows:

Check, no treatment, yielded 219 bu. per acre
Spray, bordeaux, yielded 364 bu. per acre, a gain of 145 bu.
Dust, 20-80 fresh mixed, yielded 333 bu. per acre, a gain of 114 bu.

In both experiments the sprayed plots outyielded the dusted plots. The margins, however, between the increases due to spraying and the use of the fresh mixed dusts was relatively small. It is significant to note that the fresh mixed dust produced greater increases per acre than the commercial mixed dusts with the exception of one of the experimental dusts furnished by the General Chemical Company. It is also evident that eight applications gave a considerably greater increase per acre than four applications.

FEEDING LEGUME HAY TO CHICKENS

D. C. KENNARD AND GEORGE LINGLE

The best substitute for green feed undoubtedly is a high quality leafy immature cut legume hay, which may be regarded as dried green feed. The Ohio Station's tests during the past four years have yielded highly satisfactory results when the proper quality of alfalfa, red clover, or soybean hay was used for winter green feed. The hays proved as effective as succulent green feed or a bluegrass range for maintenance of health of the flock, egg production, and hatchability.

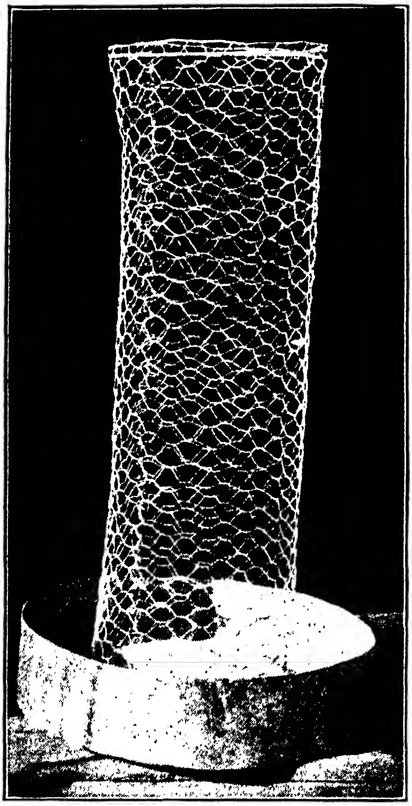


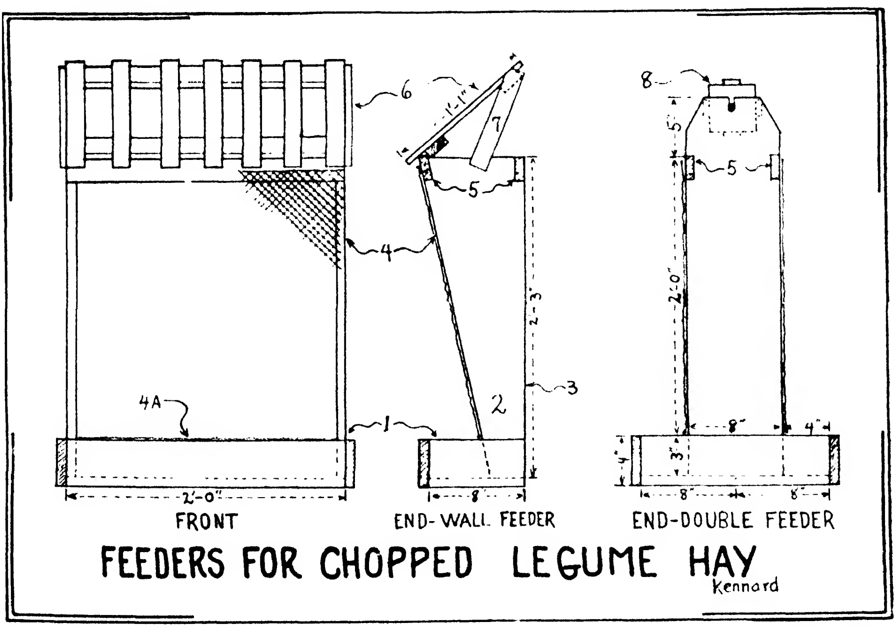
Fig. 1.—Wire netting basket feeder, set on the floor for chicks; later it is suspended by wire from ceiling.

The dried green feed has the special advantage over the succulent form because it can be fed without interruption during the coldest weather. The chickens like the hay and eat large quantities of it. They even seem to prefer the hay sometimes to the same material in its fresh succulent form. Better results were secured during the last year with the chopped alfalfa hay than with either 5 or 10 percent addition of alfalfa leaf meal to the same mash mixture.

While the feeding of chopped legume hay is rapidly coming into practice the procedure is yet comparatively new. But as soon as they come to realize its value as an essential part of the complete ration required for winter feeding or for flocks confined indoors or on limited range, many poultry keepers will endeavor to have a patch of legume hay to furnish dried green feed for the chickens. They will consider it a fundamental part of the management.

Legume hay of the quality desired for poultry is not usually available on the market. For this reason poultrymen find it necessary to produce their own hay. In the near future when the value of legume hay as a dried green feed becomes more generally recognized and the demand becomes established the desired quality of hay for poultry will no doubt become a standard market commodity in most localities. However, there are today many poultry keepers who are either producing their own hay or who procure a special quality of alfalfa hay for this purpose and the Station receives numerous inquiries as to how is the best way to feed it. The most satisfactory way, according to the Ohio Station's tests, seems to be to pass the hay through a clover or silage cutter to cut it in ¼- to ½-inch lengths and feed it in wire netting feeders. Plans for construction of the feeders follow.

Fig. 2.—Wire netting feeder for chopped alfalfa, clover, or soybean hay. This feeder will serve for either chicks or mature birds. When used for older birds it is elevated four inches off the floor.



WIRE-NETTING FEEDERS FOR CHOPPED LEGUME HAY

Three different types of feeders have been in use at this Station—the cylindrical form Fig. 1, the wall feeder Fig. 2, and the double feeder Fig. 3. The cylindrical feeder consists of a wire netting cylinder 8 inches in diameter and 24 or 30 inches high, which is attached to a bottom receptacle 16 inches in diameter and 4 inches deep. The cylinder should be strengthened by upright No. 9 wire stays on opposite sides and attached to the bottom and top to keep it from stretching out. The top also needs to be made rigid by a rim of number-9 wire, to which the upright stays are attached.

Later and improved types of feeders have recently been designed by the Ohio Station. The plan and details are given in Fig. 3. For layers the feeders are elevated four inches off the floor, and for chicks they are set on the floor.

In the use of any of the wire netting feeders, the chopped hay should be put in loosely, making no attempt to settle or pack it down, then it will automatically feed down as the birds eat it.

OATS FOR THE LAYERS

D. C. KENNARD AND L. B. NETTLETON

Feeding oats in the laying ration gives rise to two pertinent questions. First what is the value of oats in the ration, and second, which is the best method of feeding it?

Many poultry feeders attach a high traditional value to oats in the ration, but there is a considerable difference of opinion, probably because of a lack of definite information, on this question. When oats is made a part of the ration it usually replaces a corresponding amount of some other grain, usually corn or wheat. The question then is, which benefits the hen more the corn and wheat or oats? The Ohio Station is attempting to find an answer to this question. Rations containing no oats have been and are being tested against rations otherwise the same but containing oats. Further work will be required to secure conclusive results.

The other question, or which is the best method of feeding oats, is also of interest. A test is now in progress in which 50 White Leghorn pullets in each group are being fed 20 percent oats in five different ways in connection with all-mash rations: 1. Fine

ground oats; 2. A corresponding amount of germinated oats; 3. Coarse ground oats; 4. Steel-cut or pin-head oats; 5. Whole oats mixed with the mash. A sixth group receives a similar ration without oats.

The test as yet offers no indications as to probable final results except as to the feeding of whole oats instead of ground oats as a part of the all-mash mixture. The preliminary results suggest that where it is desired to feed oats it is just as well to mix the whole oats in with the mash at the rate of 10 to 20 percent by weight as to go to the trouble and expense of grinding it. This overcomes one of the objections and disadvantages of using oats as an ingredient in the mash because it is difficult to grind. Another advantage of feeding whole oats is that its weight and quality can be readily observed. This is an important point because only high quality, heavy oats should be used in the poultry ration. We are not as yet able to say whether or not grinding the oats enables the fowls to utilize it to better advantage.

THE DISTRIBUTION OF POPULATION BY AGE GROUPS ON FARMS, IN VILLAGES, AND IN CITIES IN OHIO

P. G. BECK

The farms of Ohio are sending a large percentage of their youth into urban industries. A study made of two townships in northwestern Ohio indicates that about half of the children over 18 years of age born to the families living in the townships have gone into urban occupations. That this condition exists in many, if not all, sections of Ohio, is indicated by the following table:

Percentage of Population of Ohio on Farms, in Villages, and in Cities, by Age, 1920*

Age	Total	Farm	Village	City
Under 15 years	100	22.3	17.7	60.0
15–19 years	100	23.1	15.9	61.0
20–44 years	100	15.9	14.3	69.8
45 and over	100	22.2	19.0	58.8
Total	100	19.8	16.5	63.7

*Calculated from figures of Bureau of Census, Census Monograph VI, "Farm Population of the United States, 1920".

In 1920, 19.8 percent of the total population of Ohio was farm population. However, 22.3 percent of the children under 15 years of age were on farms, while the urban group with 63.7 of the total population had but 60 percent of the children under 15 years of age. Of the persons in the 20-44 age group, 15.9 percent were on farms, 14.3 percent in villages, and 69.8 in cities. Thus the cities had more than their natural proportion of persons in this age group while the farm had less than its share. Migration from farm to city is the only explanation of this difference between age groups, since most migration takes place after the age of 20 years.

Another way of stating these differences is to calculate the number of persons under 15 years of age per 1000 persons 20-44 years of age. In 1920 in Ohio the farms had 994 persons under 15 years per 1000 persons 20-44 years of age; the villages, 888; and the cities, 611. So far as is known the differences in the farm and urban birthrates are not large enough to account for these proportions. The loss of persons between the ages of 20 and 45 by the farm represents a gain of persons in this group to the city, thus accounting for the 383 more children under 15 per 1000 persons 20-44 years of age on the farm than in the city.

Since the urban population of Ohio in 1925 was practically four times as great in number as the farm population, this migration of farm youth to the city will be felt less in the city than was formerly the case when the farm population was relatively greater. Since as many as 50 percent of the farm youth in some localities enter city occupations, the problem of health, education, and training of farm youth is more than a local issue. It is to the best interests of the State as a whole that these youth be mentally and physically fit to take their place in society.

THE DISTANCE WALKED IN THE FEEDING AND CARE OF LIVESTOCK

J. F. DOWLER

An average distance of 99 miles a month was walked to feed and care for the livestock during the winter season on a group of farms in Putnam County. This figure was secured by the use of pedometers which the worker carried in his pocket and automatically registered each step taken. There was quite a variation in the

distance walked per farm and per animal unit of livestock. Records collected by the Rural Economics Department show that over 11 miles a month was walked on each of two farms to care and feed an animal unit of livestock, as contrasted with less than four miles walked on another farm, as shown by Table 1. An animal unit consists of one horse, one cow, five sows, seven sheep, or an equivalent of one horse or cow in young stock.

TABLE 1.—Distance Walked in the Feeding and Care of Livestock on 11 Farms in Putnam County

Farm	Miles walked: Weekly	Miles walked: Monthly	Livestock: Horses	Cattle: Cows	Cattle: Other	Swine: Sows	Swine: Other	Sheep	Total animal units	Monthly per animal units
	Miles	*Miles*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*Miles*
1	8.0	33	4	2	2	1	12	0	9	3.7
2	29.0	124	4	6	15	13	65	0	29	4.3
3	11.5	49	3	3	0	6	38	7	11	4.5
4	18.0	77	5	6	0	13	53	0	16	4.8
5	21.0	90	4	7	4	7	38	0	18	5.0
6	24.0	103	3	6	10	7	14	C	19	5.4
7	10.5	45	2	4	0	8	0	0	8	5.6
8	24.0	103	4	5	3	7	25	0	16	6.9
9	41.0	170	6	7	7	11	5	12	18	9.4
10	31.5	135	2	3	6	5	24	0	12	11.3
11	32.0	137	5	3	4	5	8	0	12	11.4
Av.	22.7	99	3.8	4.7	4.6	7.5	27.4	1.8	15	6.3

Farm 2 had the largest amount of livestock. The miles walked per month on this farm was exceeded by three other farms, each of which had considerably less livestock. The efficiency with which livestock was cared for is shown by the 4.3 miles walked per animal unit, which is next to the lowest amount on this group of farms.

Farms 3 and 10 had practically the same number and kind of livestock, but there was a difference of 86 miles a month walked for their care. On the former farm the distances walked was 49 miles a month, or 4.5 miles per animal unit; while on the latter farm the distance was 135 miles a month, or 11.3 miles per animal unit.

The saving of steps on Farms 2, 3, and others with similar records was made possible by the buildings' being conveniently located, and the interiors efficiently arranged for livestock care. Cribs of corn and feed bins were handy. Self-feeders and drinking fountains w ere used for growing pigs.

On the three farms requiring the greatest amount of walking to care for the livestock, the water pail was depended upon to supply water to the hogs. Few self-feeders were used. Corn was carried and fed to livestock. More time, labor, and steps were used

to care for the livestock because of the lack of proper equipment and facilities. Miles of steps can be saved by conveniently arranged buildings and the efficient use of equipment in the feeding and care of livestock.

INDEX NUMBERS OF FARM TAXES IN OHIO

H. R. MOORE

An index number of farm taxes is presented in Table 1. A similar series was published in the Bimonthly Bulletin of November-December, 1925. The present publication brings the series up to date.

This index is computed from the total uniform property tax levy in the most rural township in each of the 88 counties of the State. This method of selection was followed to secure in each county a well defined unit representative of farm taxation. The tax valuations in the 88 townships so selected are influenced but slightly by urban land values or by the presence of industrial or public utility property.

The index number indicates the relative amount of tax from year to year. The taxes levied in 1913 were taken as the base, 100. The upward trend from that year to 1925 was more rapid than for any previous period. It is significant that the index for 1926 is the same as the index for 1925. The evidence would seem to indicate that the peak of rapidly rising taxes has been reached. Post-war expenditures affected the tax levies very decidedly in 1919 and 1920. Since then the trend has been upward but at a declining rate that is approaching the yearly increase, which was normal before the war.

Column 3 of the table shows the index of taxes expressed in terms of farm prices. It is easily observed how the trend in taxes is modified when put in terms of prices. As prices rise a given sum paid in taxes is less burdensome. Conversely, when prices fall the tax burden is increased. The period 1917-1919, inclusive, illustrates the comparatively light tax burden when prices were high. The period 1920-1923 illustrates how the tax burden increased when prices declined. It will be observed that, while the amount of taxes levied in 1925 and the amount levied in 1926 were the same (column 1), the relative burden was slightly greater in 1926 (column 3).

Another useful comparison is the tax per capita in this same area (columns 4 and 5). The tax per capita was obtained by divid-

ing the total levy in the 88 townships each census year by the total population of these townships in the same year. The population in 1926 was estimated from the arithmetic rate of decrease from 1910 to 1920. In column 4 the tax per capita is expressed in current dollars and in column 5 in constant dollars adjusted to the terms of prices of Ohio farm products.

The index each year is of the taxes levied in that year. Considered from the standpoint of payment, the 1926 index, for example, is representative of the taxes paid in December 1926 and June 1927.

TABLE 1.—Index Numbers of Ohio Farm Taxes, Farm Prices, and Taxes in Terms of Prices; Farm Tax Per Capita in Current Dollars and Constant Dollars

Year	Farm taxes (1913=100)	Price of Ohio farm products (1913=100)	Taxes in terms of prices	Tax per capita	
				Current dollars	Constant dollars
1880	60.0	89.4	67.1	6.11	6.83
1881	61.0	96.1	63.5		
1882	63.7	83.6	76.2		
1883	67.3	81.1	83.0		
1884	69.2	71.5	97.4		
1885	69.3	65.3	106.1		
1886	68.8	69.8	98.6		
1887	69.8	78 3	89.1		
1888	69.4	68.5	101.3		
1889	66.7	64.1	104.1		
1890	69.2	73.9	93.6	7.49	10.14
1891	60.6	71.1	85.2		
1892	63.8	71.2	89.6		
1893	63.7	73.3	86.9		
1894	63.6	63.4	100.3		
1895	63.5	61.4	103.4		
1896	62.4	52.5	118.9		
1897	63.4	55.5	114.2		
1898	64.9	60.6	107 1		
1899	67.6	61.8	109.4		
1900	68.7	68.4	100.4	7.71	11.27
1901	66.1	69.0	95.8		
1902	65.8	75.8	86.8		
1903	74.9	72.7	103.0		
1904	75.2	72.4	103.9		
1905	77.7	75.6	102 8		
1906	82.6	78.8	104.8		
1907	84.8	86.7	97.8		
1908	93.7	86.5	108.3		
1909	95.1	94.6	100.5		
1910	95.2	99.9	95.3	11.73	11.74
1911	86.8	86.4	100.5		
1912	91.9	97.8	94.0		
1913	100.0	100.0	100.0		
1914	101.3	101.0	100.3		
1915	131.0	101.9	128.6		
1916	129.1	116.3	111.0		
1917	130.5	175.0	74.6		
1918	142.0	195.2	72.7		
1919	169.7	209.6	81.0		
1920	197.4	203.8	96.9	26.47	12.99
1821	215.8	126.9	170.1		
1922	209.9	122.1	171.9		
1923	217.6	128.8	168.9		
1924	220.5	127.9	172.4		
1925	231.5	152.9	151.4		
1926	231.5	149 0	155.4	32.81	22.02

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

Since June the price ratio of non-agricultural and Ohio farm products has maintained a more favorable relationship than at any period since the war. For June and succeeding months the price index of non-agricultural products has been 150, 151, 151, 152. and 153, while that for Ohio farm products has been 147, 147, 149, 149, and 150.

It is interesting to note that in September the Bureau of Labor Statistics adopted a new base for their price series. Heretofore the year 1913 has been used as a base of 100. In the new series, the year 1926 is adopted as a base of 100 and henceforth price changes will be indicated as varying from the 1926 base. The 1913 base is now fourteen years old and for that reason can perhaps no longer be called normal. Apparently post years have given rise to new normals.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Non-agricultural products U. S.	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Farm products prices Onio
1913	102	....	105	100	104	100	104
1914	100	100	97	102	102	102	1u5
1915	103	101	101	100	103	107	106
1916	130	114	138	117	113	113	121
1917	181	129	182	176	140	119	182
1918	198	160	188	200	175	131	203
1919	210	185	199	209	204	135	218
1920	230	122	241	205	237	159	212
1921	150	203	167	116	164	134	132
1922	152	197	168	124	145	124	127
1923	156	214	171	135	166	122	134
1924	152	218	162	134	165	118	133
1925	161	223	165	146	165	110	159
1926	154	228	161	136	170	105	155
1926							
May	154	226	160	139	....	....	161
June	155	228	160	139	....	....	161
1927			156?				
January	150	232	155	116	169	....	145
February	149	231	153	127	....	....	145
March	148	234	151	126	....	99	144
April	147	230	150	125	172	....	144
May	147	230	150	126	....	....	145
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Ohio Agricultural Experiment Station

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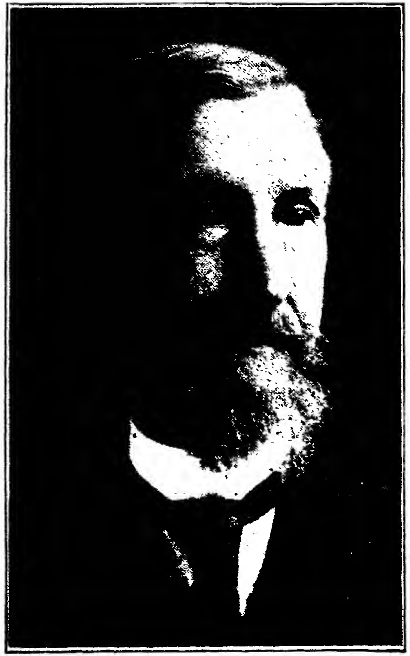
OHIO AGRICULTURAL EXPERIMENT STATION

Wooster, Ohio, U. S. A.

Honoring
Dr. Charles Embree Thorne



February 2, 1928
Pomerene Hall
Ohio State University
Columbus, Ohio

A TRIBUTE TO
CHARLES EMBREE THORNE

DIRECTOR OF THE OHIO AGRICULTURAL EXPERIMENT STATION FROM 1887 TO 1921

YOU ARE HONORED as a pioneer and leader in field experiments, as one who has enjoyed the uninterrupted confidence of Ohio farmers and the respect and admiration of your fellow scientists throughout the Nation. Stedfast, undaunted you met and conquered the trials that beset the development of research in Ohio agriculture. The Ohio Agricultural Experiment Station stands today as a monument to your ideals; to your intelligent devotion to experimental science; to your leadership in the progress of Ohio agriculture; to your loyalty to the farms and farmers of Ohio.

IN RECOGNITION of your distinguished services and the high place which you continue to hold in the esteem and affection of all who have been privileged to know you, the Faculty of the College of Agriculture and the farmers of Ohio assembled in the sixteenth annual Farmers Week at Ohio State University extend their hearty congratulation and present this tribute.

The second day of February, nineteen hundred twenty-eight.

Program

Presiding — Dr. Geo. W. Rightmire
President, Ohio State University

A Lifetime in Rural Service
Dr. Eugene Davenport
Dean Emeritus, University of Illinois

A Milestone in Ohio Agriculture
Dr. W. O. Thompson
Pres. Emeritus, Ohio State University

The Farmers' Debt to Experiment Station
W. W. Farnsworth
Master Farmer, Lucas County, Ohio

Presentation of Testimonial
Alfred Vivian
Dean, College of Agriculture

Response — Dr. Thorne

THE ORIENTAL FRUIT MOTH (*Laspeyresia molesta* Busck.)

Essential Facts Concerning Its Activities, Present Status in Ohio, Suggestions for Reducing Infestation

LOUIS A. STEARNS

The Oriental fruit moth (Fig. 1), altho appearing but recently in Ohio, has been present in the United States for about fifteen years.

Between the years 1910 and 1915, there was a popular demand for the Japanese flowering cherry in this country. It is thought that the moth was introduced at that time in shipments of such stock. Extensive plantings were made in the parks of the city of Washington and elsewhere in the East, where the insect was first found in this country. Thru shipments of infested stock and, more especially, infested fruit, it has spread rapidly, quarantines proving ineffective.

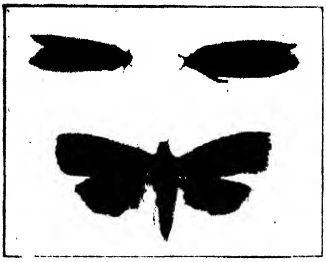


Fig. 1.—Adults of the Oriental fruit moth

In the present area of infestation, which includes all of the important peach-producing districts in the East and certain of those in the Middle West, the moth promises to become the most important peach insect and an occasional destructive pest of other orchard fruits.

DISTRIBUTION IN OHIO

This insect is now generally distributed thruout the peach growing areas of Ohio.

The infestation is most severe along the Ohio River, especially in Hamilton County about the city of Cincinnati and in Lawrence, Gallia, and Meigs Counties; in the center of the State to the south of Columbus; and in the north in the vicinity of Sandusky, Lorain, and Elyria. It seems probable that the sale and inadequate disposal of infested peaches in the cities mentioned have resulted in the establishment of the moth in the commercial orchards of the surrounding country. Altho the insect has been present in these centers of infestation, supposedly but a short time, injury is already fully as severe as in certain sections of the East, where it was introduced several years ago.

At present, there is practically no infestation in the important peach-producing area of Ottawa County on Lake Erie.

Here, and elsewhere in the State, except the extreme southern part, an increase of infestation in 1928 is probable. In southern Ohio, the failure of both peach and apple crops due to killing frosts and parasitic activity in 1927 undoubtedly resulted in a decrease in the number of wintering larvae. In this section, the infestation should be either subnormal or stationary.

FOOD PLANTS

The larva (worm) is the only injurious stage in the life cycle of the Oriental fruit moth. The larvae damage both the twigs and fruits of most orchard trees.

Twig injury is most severe and conspicuous in spring and early summer. Larvae usually burrow into the tip of a twig near the base of one of the unfolding leaves, the feeding tunnels varying from one to two inches in depth. The tip of an infested twig soon wilts. Later, the terminal leaves wither, turn brown, and die (Fig. 2).

Fig. 2.—Typically injured peach twig

Injury to the tender, succulent, terminal growth of the peach and plum is serious, to that of cherry and quince moderately severe, and to apple but occasional.

Twig injury on bearing trees is seldom considered important by the average fruit-grower. The ability to feed in twigs in the spring is responsible, however, for the tremendous yearly increase in the numbers of this insect with consequent severe damage to the fruit later in the season.

With the nurseryman, twig injury is a grave matter. The twigs of young nursery stock are most susceptible to attack, frequently as high as 90 percent of the terminals being injured. The destruction of the terminal growth results in the pushing out of shoots from the lateral buds and the production of a much-branched, bushy tree of lessened market value.

Fruit injury.—Twig-feeding may continue thruout the season; but as soon as the terminal growth begins to harden and the fruit becomes of a size and texture suitable for feeding, distinct preference is shown for fruit.

Fig. 3.—Typical early season surface injury to peach fruit

Quince is the fruit damaged most seriously by this insect. Frequently the entire crop of an isolated tree is infested, and it is not unusual to find from six to twelve larvae in a single quince.

Injury to peach fruit is, however, a close second. Altho fruit injury is highly variable, the latest ripening varieties usually suffer most severely.

Fruit injury is of two kinds. About the time the early varieties of peaches are commencing to ripen, partly grown larvae may leave the tunnels in the twigs and complete their feeding on fruits. Only the surface of the peach is eaten; gum exudes, binding excrement and leaves to the fruit. This is the characteristic early season injury (Fig. 3). Later in the summer, approximately 90 percent of the larvae select the stem end of the peach for entrance, which may be effected either at the point where the stem joins the fruit (Fig. 4) or directly thru the side of the stem and thence downward thru its center. In either case, there is usually no visible evidence that the fruit is wormy. An average of about 10 percent of the supposedly clean fruit is commonly injured in this manner.

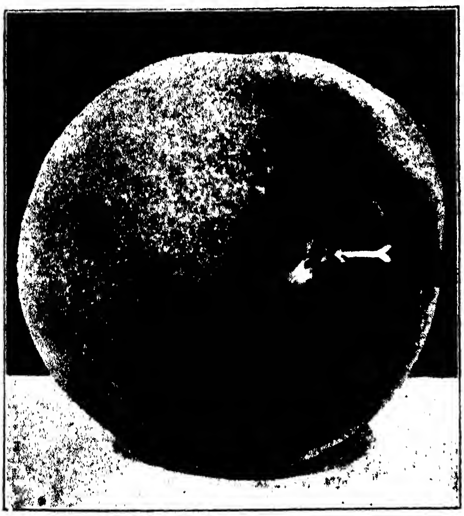


Fig. 4.—Typical mid- and late-season stem end injury to peach fruit

Within the peach, larvae generally tunnel thruout the fruit forming long, winding cavities terminating in a small, round, exit hole in the side (Fig. 5). When feeding is confined to a small area, especially in the region of the stem end or near the pit, the peach drops prematurely. The highest percentage of wormy peaches will always be found in the drops and in the first pickings from a tree.

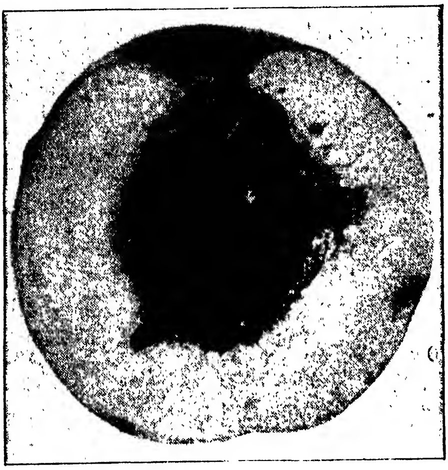


Fig. 5.—Typical mid- and late-season internal injury to peach fruit

The infestation of Elberta in Ohio, in 1927, varied from 0.5 percent to as high as 56 percent. These figures, with those of other states, suggest that under conditions of severe infestation and without adequate control an annual peach loss, gradually increasing from the early thru the mid-season to as high as 85 percent for the late varieties, may be anticipated.

In apple orchards interplanted with early and mid-season varieties of peaches or adjoining them, the possibility of late season infestation of apples should be recognized. In summer and early fall apples such injury has been negligible, but in winter varieties it may be serious. In 1925, and especially 1926, according to reports, apple infestations were both frequent and serious. They were less alarming in 1927.

LIFE HISTORY

From the preceding discussion of food plants and injury caused by the Oriental fruit moth, it is evident that its activities combine those of two well known peach and apple insects and result in more severe damage due to the greater number of broods each year. Especially during the spring, the twigs of peach and certain other orchard trees are attacked in a manner closely resembling that of the Peach Twig-Borer (*Anarsia lineatella* Zeller), an outstanding pest in California and locally abundant in certain years in other sections of this country. Unless the worm causing the damage can be found and identified, it is usually impossible to be certain which

insect is guilty. Furthermore, with increasing severity thruout the summer, the peach and certain other orchard fruits are injured as if by the Codling Moth *(Carpocapsa pomonella* Linn.), an insect with which fruit-growers thruout the country have become more or less familiar thru many years of spraying experience.

The Oriental fruit moth, like the peach twig-borer and codling moth, passes thru four distinct stages—the egg, the larva (worm), the pupa, and the adult (moth)—in the completion of its life cycle. The life cycle of the codling moth may be repeated two, or possibly three, times each year in Ohio, that of the Oriental fruit moth four or five times.

This insect passes the winter as a full grown larva cocooned either on the tree in crevices of the bark, especially on the trunk at or near soil level, or away from the tree in trash or on mummied peaches on the ground. The packing house and its equipment and the dumping grounds for cull fruit also provide favorable quarters for wintering.

Early in the spring, at about the time the peach buds begin to swell, the overwintered larvae transform to pupae and remain in this stage for about a month. The first emergence of spring brood moths from these pupae coincides approximately with full bloom of the peach and reaches a maximum two or three weeks thereafter.

Altho few eggs are deposited by these moths prior to the date of the shuck-split spray, almost one-half of the first brood eggs are deposited during the two-week period thereafter, or prior to the date of the second spray. The majority of eggs are deposited on the under surface of the leaves. Incubation varies with the temperature. It may require as many as 18 days in early spring and late fall or no more than 3½ days in midsummer.

In 1927, the first first-brood larvae had hatched and a scattering twig injury was already evident on May 1 in southern Ohio. By May 15, and thruout the remainder of the month, such injury was severe.

Young larvae are of a whitish color with a black head. They gradually become more or less pinkish with a slightly brownish head, whereas codling moth larvae develop a distinctly reddish body color and dark-brownish head. Oriental fruit moth larvae may be distinguished readily from those of the peach twig-borer, which are rather uniformly dark-brown and annulated in appearance, and from those of the Curculio *(Conotrachelus nenuphar* Hbst.), which are always white, lie in a somewhat curled position, and have no legs. When full grown, Oriental fruit moth larvae are but one-half

inch, and Codling Moth larvae about three-fourths inch in length. A variable number of days are required for development. Larvae of the summer broods mature in 7 to 18 days.

The first brood moths had deposited the first second-brood eggs and the first second-brood larvae were hatching from these eggs about June 15, in 1927. It is at approximately this time, 8½ to 9½ weeks after full bloom, that first injury to the fruit can usually be observed.

Insectary records of the total egg production (43,198 eggs) for the summer broods were secured by caging ten male and ten female moths daily and recording oviposition.

There were five distinct broods of eggs and larvae in 1927. The larvae were reared in Rome Beauty apples in the insectary. Possibly there was a slight break between the first and second broods during the first week in June. The second and third broods overlapped for a period of two weeks in late July; and the third and fourth, for a period of five weeks from late August until early October. The deposition period of the small, fifth brood coincided with that for the last eggs of the fourth, during the fourth week in October. Moths showed a varying fecundity increasing from 21 eggs per female for those of the first brood to 48 for those of the second and 58 for those of the third brood.

The third and fourth broods of eggs and larvae were approximately equal and by far the largest. Maximum numbers of third brood larvae and the first fourth-brood larvae were hatching in late August, the ripening period of the Elberta peach in central and southern Ohio. This accounts for the high degree of infestation for this variety. Later varieties of peaches should have been subject to an equal or greater infestation during September.

During the dormant season, larvae of the last three broods were feeding in apples stored in glass jars in the insectary, mature individuals emerging daily. This condition is not unlike that of "common storage".

The records of weekly collections of twig-feeding larvae in a four-year old Elberta peach orchard without fruit and the records of moths collected on the same dates from pans containing an attractive, 10 percent, syrup bait show that the initial twig injury was about May 1, in 1927. It increased rapidly, as shown by the dash line in Figure 6, thruout May and early June during the periods of activity for the first and early second brood larvae. Maximum twig infestation was between June 15 and 30. After

July 1, and proportionate to the hardening of the peach wood, a constant decline in the abundance of larvae was recorded week by week, notwithstanding the fact that during the same period moths were present in greatest numbers. During the latter part of August and thruout September, but few fresh injuries could be located.

In a normal season, the decline in twig infestation would be accompanied by a uniform increase in fruit infestation. With the peach wood hardened and with neither late peaches nor apples to feed upon in 1927, a high percentage of the late, hibernating larvae in all probability failed to mature.

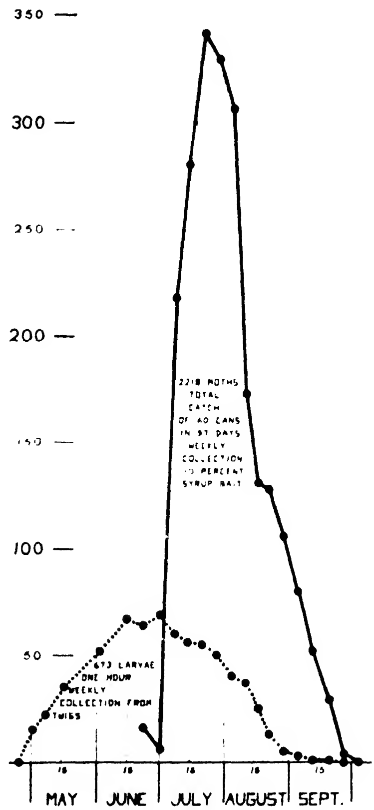


Fig. 6.—The dotted line represents the weekly collection of larvae from twigs; the solid line, weekly collection of moths from bait pans

CONTROL

Artificial measures.—An adequate, practical control for the Oriental fruit moth is yet to be devised.

The arsenical sprays commonly applied for the control of such pests as the curculio on peach and the codling moth on apple have proved ineffective in the case of this insect. The larval habit of tunneling, the tendency to feed exclusively on the inner tissue of the terminal twigs, and the rapidity of twig growth which renders the maintenance of spray coverage almost impossible, account for the ineffectiveness of sprays in the spring. The preference of the summer broods of larvae for the fruit, the habit of entering thru the stem end, the possibility of foliage injury, and the probable presence of an undesirable spray residue on the fruit combine to preclude the application of such sprays later in the season.

The results of both extensive laboratory tests and orchard spraying experiments indicate that nicotine as an ovicide will partially control the Oriental fruit moth. Under average conditions, records have shown a uniform increase in clean fruit of 10 percent,

which amounts to a return of approximately 20 cents per bushel over and above the additional cost in spray material. The eggs of this insect are present on the foliage thruout the season, the periods of maximum abundance varying from year to year. Furthermore, the incubation period is brief. It is difficult, therefore, to apply such sprays at times when they will be most highly effective. The high cost of production and the uncertain returns for peaches in the last few years are also partially responsible for the fact that this insecticide has not been generally adopted.

Baits sufficiently attractive to trap the adult female moths before eggs have been deposited have so far proved not only ineffective but prohibitive in cost when employed in accordance with present knowledge of the conditions that determine maximum catch.

Based on an accurate knowledge of the hibernation quarters of the larvae, the paradichlorobenzene treatment and spring cultivation have proved effective in reducing infestation.

Natural control—parasitism.—As many as 45 parasites of the egg, larval, and pupal stages of the Oriental fruit moth have been recorded during the interval in which it has been present in this country. That this new pest should be attacked by so many parasites within such a short time has seemed most encouraging, especially since endeavors to devise effective control measures have proved rather fruitless. Their presence indicates that parasites may eventually considerably reduce the normal number of the insect with a consequent material decrease in fruit infestation.

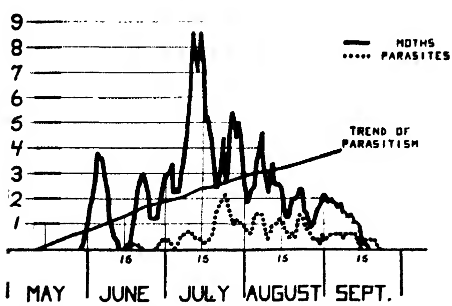


Fig. 7.—Comparative population of the Oriental fruit moth ——— and its larval parasites . . . . . and trend of parasitism ——— Lawrence County Ohio, 1927

Late in the season, a common egg parasite usually appears in considerable numbers, parasitism frequently amounting to 60 percent or higher.

At the present time, however, larval parasites are more important. These parasites, altho generally distributed, vary considerably in abundance. Six species of larval parasites are already established in eleven counties in central and southern Ohio. The two, most important species are in Lawrence, Jackson, Meigs, Washington, Ross, Fairfield, Hocking, Hamilton, and Butler Counties.

The comparative population of the Moth and its larval parasites and the trend of parasitism in a four-year old Elberta peach orchard without fruit in 1927 are shown in Figure 7. The total parasitism for the season averaged 18.7 percent, with the seasonal trend from 6 to 31 percent. These figures are highly encouraging in view of the recent establishment of the Moth in Ohio.

SUGGESTIONS FOR REDUCING INFESTATION

Follow the recommended practice of fall application of paradichlorobenzene for the peach-tree borer. This treatment is now doubly important, since this insecticide will kill practically all of the larvae of the Oriental fruit moth that are overwintering on the trunk of the peach tree at or near the surface of the ground.

If possible, cultivate thoroly in the spring during late March in southern Ohio and early April in northern Ohio, at which time the majority of overwintered larvae have transformed to pupae. Disk both ways of the orchard to a depth of at least four inches getting as close to the tree as possible without damage to the roots or trunk.

The paradichlorobenzene treatment and spring cultivation should destroy a large percentage (about 86 percent) of the Oriental fruit moth larvae hibernating in the orchard.

Do not neglect packing house sanitation and the disposal of cull fruit. Both the packing house and the dumping grounds for cull fruit serve as important sources of reinfestation from year to year.

In making new plantings, it would seem advisable to separate as widely as possible early and late varieties of peaches, no longer interplanting the two, since the larvae maturing in late fruit constitute the hibernating material. For somewhat the same reason it would seem necessary to restrict the interplanting of peaches and apples. With the removal of the peaches, the insect is left behind as an apple pest.

Peaches should be pruned and fertilized less heavily, since overpruned and overstimulated trees are injured most severely.

The most effective summer treatment yet devised is the addition of 40 percent nicotine at the 1-800 dilution (½ pint to 50 gals.) in the shuck-split application and in applications 2, 4, 7, 9, and 11 weeks thereafter. This treatment is recommended only in exceptional cases where the severity of the infestation as well as the prospective yield and value of the crop would seem to justify the additional expenditure for protection from this particular pest.

THE BLACK CHERRY APHIS

C. R. CUTRIGHT

Of the many inquiries that come to the Ohio Agricultural Experiment Station concerning aphids, or plant lice, no species is more frequently mentioned than is the black cherry aphis, *Myzus cerasi* Fab. The damage caused by this aphid, especially on sweet cherries, is so obvious that it attracts much attention.

HISTORY

The black cherry aphis is a native of the Old World and it was there first described by Fabricus in 1775. It is first mentioned in American literature by Dr. Asa Fitch in his Catalogue of Homoptera of New York, 1851. From that date to the present we find frequent mention of this insect in the reports of horticultural meetings and in agricultural and entomological publications.

HOST PLANTS

The black cherry aphis has been taken from the following hosts: spider orchis (European) *(Ophrys aranifera)*; an ornamental shrub closely related to mountain ash *(Photinea serratala)*; sweet cherry *(Prunus avium)*; sour cherry *(P. cerasus)*; mahaleb cherry *(P. mahaleb)*; wild black cherry *(P. serotina)*; choke cherry *(P. pennsylvanica)*; common European plum (rarely) *(P. domestica)*; peach (rarely) *(P. persica)*; wild pepper grass *(Lepidium apetalum)*; and probably on other plants of the mustard family closely related to pepper grass.

In all instances the preferred host is the sweet cherry; but this aphid is frequently found on sour cherry, where it lives and reproduces normally. However, on sour cherry the leaves are not noticeably deformed as they are on the sweet varieties so that its presence frequently is not noted.

LIFE HISTORY AND HABITS

The insect overwinters as an egg placed about the buds and on the rough bark of cherry trees. These eggs are quite small and are indistinguishable from the eggs of other aphids, such as those found on the young shoots of apple. They are only a little over 1/40-inch in length, oval in shape, and a shiny black in color. At Wooster the eggs are rather rare and hard to find. They hatch in

the spring during the time the buds are swelling, and the young locate themselves and feed on the expanding bud tissues.

The newly hatched aphids are dark green in color and are technically designated as "stem mothers". In Ohio they become adult usually in the fourth week after hatching and soon thereafter give birth to living young. According to W. A. Ross, entomologist of Vineland Station, Ontario, each adult can produce as many as 150 young. This is a considerably greater number than is produced by stem mothers of some other aphids and is one reason for the sudden appearance of the aphids in countless numbers. The young of the "stem mothers" become mature in about ten days, depending largely on the weather. Like their mother they are wingless and give birth to living young in large numbers. They are glistening dark brown or black in color. Their progeny may develop wings or may remain wingless, according to certain conditions that may arise. Those that develop wings fly away to other hosts while the wingless remain on the cherry and reproduce, their progeny being both winged and wingless, as in the case of the preceding, or third generation. As the wood in the growing shoots hardens and as the lice become more crowded the proportion of winged forms increases till finally practically all the lice become winged and leave the cherry.

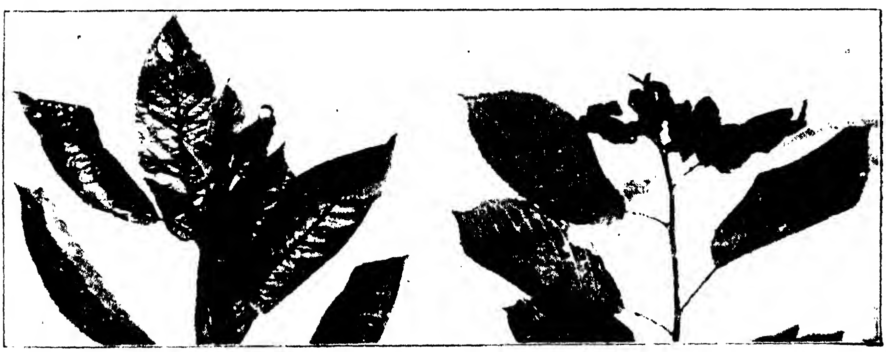


Fig. 1.—Normal uninfested sweet cherry terminal, left. Distorted foliage caused by the black cherry aphis, right

The plant or plants to which the winged aphids go upon leaving the cherry had long been sought but were not found until 1917, when it was discovered by W. A. Ross that they go to the wild peppergrass and possibly some of the related plants of the mustard family. When the lice find these plants they feed upon them and give birth to black wingless lice that live and continue reproduction

during the summer months. As autumn approaches, winged lice appear and these leave the peppergrass and return to the cherry. Here they give birth to an egg-laying form that is later fertilized by a winged male that developed on the pepper-grass and then migrated to the cherry. After fertilization the females lay the overwintering eggs.

The exact date of leaving the sweet cherry is influenced largely by the type of growth that the tree is making. In Ohio, however, migration is practically always completed during the last two weeks in June, and I have never noted a colony of the aphid present on the trees during late July or August. On sour cherry the situation is somewhat different. Here some of the water sprouts may continue to grow during the entire summer, and on these shoots I have observed colonies of the lice thruout the season. Ross reports that colonies such as these may give rise to the egg-laying females, but that the males come only from the pepper-grass.

NATURAL ENEMIES

The lice may be attacked at any time during their life cycle, except in the egg stage, by predaceous enemies, such as the lady-bird beetles and their larvae, by the green and brown lace-wing flies and their immature forms, and by the larvae of the syrphid flies. Many parasites also prey upon them. These natural enemies destroy countless numbers of aphids, but in my experience I have never seen an outbreak of these aphids controlled by natural enemies. Their seasonal injury to cherry is terminated by migration.

CONTROL

During the last three years, spraying experiments have been conducted against the black cherry aphis. The tests were carried on in the orchard of sweet cherry trees at the Station, in cooperation with the Horticultural Department.

In 1925 no early season applications of sprays were made. About May 20, after petal fall of that year, the trees were found to be heavily infested and were thoroly sprayed with liquid lime-sulfur 1-40 to which was added nicotine sulfate 1-800, or 1 pint to 100 gallons. A great many lice were killed but these probably did not amount to more than 50 percent of the total present. As those left alive continued to reproduce young, only a day or two elapsed till there were fully as many lice on the trees as at the time of spraying. The poor results of this application were due to the tightly curled leaves which protected many lice from the liquid.

These results are the same as may be expected when attempting to spray at any time against lice that have already deformed the foliage. Similar experiments with like results have been conducted elsewhere many times and can lead to one conclusion only—namely: that spraying against the black cherry aphis after it has deformed the foliage is a waste of time, labor, and materials.

In 1926, on the 23d of April, the cherry orchard was sprayed. The buds were well swollen but had not broken. The materials used and results secured were as follows:

Plot	Materials		Infested terminals on June 10
Plot 1	Liquid lime-sulfur	1-7	12.6 percent
Plot 2	Liquid lime-sulfur Nicotine sulfate	1-7 1-800	1.6 percent

There was a very light infestation in 1926, but the differences between the two plots were distinct. There were no unsprayed checks.

In 1927 the orchard, with the exception of Plots 1 and 2, was sprayed with Sunoco spray oil 1-20, April 4. At that time the trees were dormant. About two weeks later, with buds well swollen, Plot 1 was sprayed with liquid lime-sulfur 1-7, and Plots 2 and 3 with the same material to which nicotine sulfate was added at the rate of 1-800, or 1 pint per 100 gallons. The effectiveness of the treatments was recorded by counting infested and non-infested terminals, June 15 as follows:

Plots	Materials	Infested terminals	Non-infested terminals	Percent infested
1	Liquid lime-sulfur 1-7 (Delayed dormant)	412	4	99
2	Liquid lime-sulfur 1-7 Nicotine sulfate 1-800 (Delayed dormant)	174	170	51
3	Sunoco spray oil 1-20 (Dormant) Liquid lime-sulfur 1-7 Nicotine sulfate 1-800 (Delayed dormant)	20	303	6

Plots 1 and 2 were adjacent and there was every indication that considerable migration from 1 to 2 had occurred. Branches from Plot 1 frequently touched those of Plot 2 and on the side of the trees in Plot 2 nearest to Plot 1 the infestation was always greatest. The terminals on Plot 2 were very lightly infested as compared with the terminals on Plot 1, which were literally

covered with lice. Therefore, we do not believe that the percentage of infestation of Plot 2 is a true indicator of the conditions. The percentage of infestation should probably be nearer 10 or 15 percent than 51 percent.

RECOMMENDATIONS FOR CONTROL

Almost perfect control was obtained by the use of an oil spray in the dormant period followed by dormant strength lime-sulfur and nicotine sulfate just before the buds opened. It is thought, however, that the latter spray alone, if thoroly applied before the buds burst, will effect a practical control. This has been found true in other states and in Canada. These recommendations for the control of this insect apply to both sweet and sour cherries. Spraying sweet cherries after the buds have opened is useless. On sour cherries, due to the fact that the aphids do not curl the leaves, it would seem possible to use a nicotine spray with fair chances of success. The following formula is recommended for summer spray:

Liquid lime-sulfur	1-40
or	
Dry lime-sulfur	3 lb. — 50 gal.
Nicotine sulfate	1-800 (1 pt. — 100 gal.)

For dormant oil sprays, follow the directions of the manufacturers, or in the case of home mixed oil emulsions use:

Oil emulsion	4½ gallons
Water	100 gallons

For lime-sulfur-nicotine spray in the delayed dormant:

Liquid lime-sulfur	1-7
or	
Dry lime-sulfur	15 lb. — 50 gal.
Nicotine sulfate	1-800 (1 pt. — 100 gal.)

JAPAN AND KOREAN CLOVERS

J. S. CUTLER[1], S. C. HARTMAN[2], W. E. WEAVER[3], AND WALTER MAHAN[4]

Two related legumes, which are comparatively new to Ohio Agriculture, show considerable promise and are steadily gaining headway in the pastures of southern Ohio. They are Japan clover *(Lespedeza striata)* and Korean clover *(Lespedeza stipulaceae)*. Various tests and observations on these clovers have been in progress for a number of years on the Southeastern Test Farm in Meigs County and on the Washington, Belmont, Clermont, and Hamilton County Experiment Farms, in cooperation with the U. S. Department of Agriculture. The results and some practical suggestions are reported here.

Japan clover is supposed to have been introduced into this country in a shipment of tea from Japan, hence its name. It was reported in South Carolina and Georgia about 1846. During the civil war seed was distributed by the cavalry to points in Tennessee, Alabama, Louisiana, and Mississippi. It has gradually spread northward in permanent pastures, coming into Ohio from Kentucky and West Virginia. Korean clover was introduced at a later date direct from Korea.

The lespedezas are summer annuals, each year's stand always coming from seed. Their method of reseeding, however, usually makes them permanent, even under close pasturing, where the growing season is long enough to permit the plant to ripen seed. The seed is short lived, two-year old seed having low germination. Growth does not take place until late in the season, the plants furnishing little pasture until late summer when the blue grass is dead and dry and other pasture usually is short. Growth continues until killing frost. The lespedezas are quite drought resistant and so produce pasture from the first of August on, even in dry weather.

The plants have slender central stems with spreading branches. The height varied from 4 or 5 inches to 12 or 14 inches in the Ohio tests, depending on how favorable conditions were for growth. On the poorer soils these clovers make a thick mat over the ground. The seeds are borne on the branches and offshoots

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near the tip. The flowers appear in September. They are small, scattered, pea-shaped, and of a purplish color with extremely small petals. Often the flowers are not noticeable because of the small, undeveloped petals, but this does not interfere with seed production as the plants are self-pollinated. The seeds are borne singly in pods at the axis of the leaves and are more numerous near the tip of the plant. The seeds form quickly and grow well, even when the plants are killed by frost while still green.

Japan and Korean clovers do not compete with any other legume. Growing as they will in permanent pastures thru the mid and late summer months, they markedly influence both the quality and quantity of the pasture. They also have the advantage of being readily killed by cultivation. The length of growing season apparently influences the amount of seed produced. The further north the plants are grown the fewer seeds per plant

Japan vs. Korean clover.—Korean clover is larger, coarser, and blossoms earlier than Japan clover. The leaflets are appreciably larger, broader, and the green leaves have a duller grayish hue than the Japan. The leaves turn forward and by overlapping one with another make the tips of the branches appear cone shaped. The central stem with many branches is conducive to good seed production. Tests elsewhere indicate that the Korean clover is more drought resistant than the Japan. In some tests Korean excelled Japan, while in others the reverse was true.

A third species, Kobe lespedeza, is primarily adapted to the cotton belt, where it makes a greater growth and seeds more profusely than the Japan. In Ohio to date it has proved inferior to either the Japan or the Korean.

Adaptation in Ohio.—The tests with Japan and Korean clovers on the outlying farms of the Station indicate that both are adapted primarily to southeastern Ohio and especially to the counties bordering on the Ohio river. Tests on the Belmont County Experiment Farm indicate that it is at the approximate present northern edge of the area. Roughly speaking, Korean and Japan clovers are adapted to the area lying south and east of Fairfield County. Both show some promise in the counties adjacent to the Ohio River in southwestern Ohio. Their distribution is apparently limited by the length of growing season. While definite evidence is lacking, it seems likely that the present area of adaptation may be extended further north by the use of the larger and earlier Korean clover.

The lespedezas are suited only to pasturing in Ohio, since nowhere in the State do they make sufficient growth for a satisfactory hay crop. The plants are high in protein and noticeably increase the feeding value of pasture. They are palatable and are readily eaten by most classes of livestock.

The origin of Japan clover seed is of importance in determining its adaptation. Japan clover from seed produced in Louisiana failed to perpetuate itself at the Southeastern and Washington County experiment farms, while a Tennessee strain succeeded. The Tennessee Experiment Station has shown that ordinary seed is a mixture of early and late maturing strains. As the crop is grown further north the larger growing strains fail to produce seed, while the smaller, earlier maturing plants tend to increase. In this way the crop has gradually spread several hundred miles north of its earlier habitat. Seed produced in Ohio has been found to be better adapted than seed grown elsewhere

Will grow on poor acid soils.—Both Japan and Korean clovers do well on acid soils of low fertility. Tests in some twenty Ohio counties[1] indicate that the pasture soils are not sufficiently acid to prevent growth. It has been found growing on soils with a pH as low as 4.4. Satisfactory growth as well as failures have been reported on eroded unfertile soils where the pasture is poor, and also in moderately shaded areas. Good growth has been secured in pastures where the only other vegetation was broom sedge, poverty grass, and moss. Applications of lime and phosphorus markedly increased the amount of growth on most soils in this area which is low in available phosphorus and lime.

Securing a stand.—Japan and Korean clovers are usually seeded broadcast over old pasture sod in winter or very early spring. Early seeding permits freezing and thawing in the spring to cover the seed. The seed usually germinates in May. Covering the seed by artificial means is seldom practical, especially on the rougher pasture lands.

Four pounds per acre is sufficient seed for a light stand. This will produce enough seed the first year to seed the area if it is going to thrive. Heavier seedings are not likely to give any better results. If conditions are favorable the lighter seeding will prove satisfactory; if they are not, heavy seeding will not aid in securing a permanent stand. The germinating ability of the seed is not seriously impaired by passage thru the alimentary tract of most

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[1]Extension Bulletin No. 61, p. 15, by M. V. Bailey of the Ohio State University.

animals, and it is distributed from place to place by grazing animals and birds. The seed as sold on the market is usually unhulled, weighing about 25 pounds to the bushel.

The best stands have been secured where the pasture sod is thin and bare spots occur. When it spreads naturally it usually appears first in the hard-packed bare paths in a pasture. Only thin stands of Korean clover were secured when the seed was sown on a fairly heavy blue grass sod. This may have been due to the sod's preventing the seeds from reaching the soil and being covered and to competition with the blue grass as the young plants were starting. Earlier sowing might have obviated this difficulty. Reports indicate that blue grass, under favorable conditions for it, may crowd out Japan and Korean clovers, but in other conditions they have competed successfully.

Inoculation is usually advisable. However, the seeds frequently carry the inoculating organism on their rough seed coats. The lespedezas have the same nodule bacteria as the cowpea, partridge pea, and tick trefoil.

SUCCULENT DAIRY FEEDS

A. E. PERKINS

Cows are at their best when pasture or other green feed forms the bulk of their ration. Winter cuts off the supply of these feeds and other conditions often make their use impractical.

Corn silage has become a standard ingredient in the winter ration in most of the larger dairies. It provides succulence—succulence is a general term here used to describe the tonic or conditioning properties of green feeds which are not generally found in the dry feeds forming the bulk of the usual winter ration. It not only supplies succulent feed but also affords a convenient and economical way of harvesting, storing, and feeding the corn crop. It is unfortunate that the overhead expense and various practical difficulties involved prevent the use of silage for the smaller herds (less than 10 cows) as well.

Where it is impractical to use corn silage it is often possible to supply succulence to advantage in some other form. One of the root crops, as carrots, beets, or mangels, may be grown for the purpose. Because of the high labor requirement for growing, harvest-

ing, storing, and feeding these crops, they can not profitably make so large a proportion of the commercial dairy ration as corn silage. Doubtless smaller amounts of these feeds, which would still furnish an adequate supply of the succulent properties to be of great benefit to the cow and her production, could be grown and fed to advantage, especially where silage is not available. Mangels, as indicated by our experiments, are probably the most practical of these crops to raise. They grow largely above ground and the labor required to harvest them is less than that required by the other root crops.

The pumpkin interplanted with corn or grown alone is another crop frequently used to provide succulence for dairy cows. Pumpkins are especially useful for this purpose in late fall and early winter. However, since they are bulky and require much space for storage and decay easily, they are not well adapted to late winter and spring use.

Cull apples and potatoes are usually well liked by dairy cows. Altho these commodities are not likely to be produced especially for dairy feeding, yet they are often available as waste products and can be fed to advantage. All these succulent feeds must be protected from freezing to be available during the winter season when they are most needed.

Apple pomace either fresh or ensiled may be utilized to advantage as a succulent feed for dairy cows. This by-product of cider manufacture has been shown experimentally to be practically equal in feeding value to corn silage. Being more compact, it can be ensiled to better advantage than corn, in heaps, pits, or small improvized silos. Dried apple pomace has appeared on the market in some sections of the country. Its value is much the same as that of dried sugar beet pulp.

Sugar beet pulp, which is available on the market in dry form, possesses considerable value as a source of succulence. It can be easily stored and used whenever and wherever needed. The dried material is commonly soaked with about three times its own weight of water. In this condition it has practically the same chemical composition as corn silage. Usually it is too high in price to permit its economical use on as liberal a scale as would be the practice with silage. Like the roots and similar materials it may sometimes be used to advantage in smaller quantities and would probably be worth much more under some conditions than is indicated by its composition in comparison with other feeds. Sugar beet pulp is highly prized by expert feeders for use in the rations of cows that are being forced for heavy production. It is also a favorite ingredient with manufacturers of proprietary feeds.

Molasses is now used largely by the manufacturers of proprietary mixed feeds to add to the attractiveness of these feeds. It could probably be used to advantage at times by the small farmer as the source of succulence. Neither cane nor beet molasses, at prices prevailing in Ohio, can be profitably used in large quantities to compete with corn or other grains as a source of energy in the ration. Where other succulent material is lacking, however, it may very likely be used to advantage in small quantities on account of the benefit to the animal resulting from its appetizing, tonic, and conditioning properties.

Summarizing, we may say that there are numerous feeds that may be used in connection with the winter ration to take the place, in part at least, of the tonic effect inherent in summer pasture.

With the possible exception of apple pomace, silage is the only one of these feeds that ordinarily can be used with profit as a major portion of the dairy ration, in competition with the common dry feeds.

Because of high cost of production, high market price, or high cost of storing and feeding, the others can profitably comprise only a much smaller part of the commercial dairy ration. Some one or more of these materials may be provided regularly in small amounts to good advantage or more freely if available at a favorable price. Their use is likely to result in a decided benefit to the condition and well-being of the animals and also an increase of production and profits.

The use of one or more of these feeds as indicated would doubtless go a long way toward eliminating the supposed need of most of the material sold to Ohio farmers at exorbitant prices under the guise of nostrum and tonic preparations.

THE EFFECT OF HIGH AND LOW PROTEIN RATIONS ON THE FOOD VALUE OF MILK FOR CALVES

C. C. HAYDEN AND W. E. KRAUSS

A study of the effect of high and low protein rations on the production and physical condition of cows has been in progress at the Ohio Experiment Station for several years. Some of the results of this work were reported in 1925 in Bulletin 389. Since that time rations even more extreme as to protein content have been used, the nutritive ratio of the high protein ration being 1:2 and that of the low protein ration 1:13. Since rations considerably higher or lower in protein content than the amount usually recommended are sometimes fed, it was thought expedient to determine whether or not milk from cows so fed could be safely used for feeding calves.

While there is no experimental evidence that the amount of protein in itself affects the quality of the milk for calves, it is possible that the milk may be affected indirectly by some physiological upset of the cow. Furthermore, some work with rats done elsewhere showed that when an excessive amount of protein was fed to lactating mother rats their milk was toxic to nursing young.

Complete data on six purebred Holstein heifer calves dropped by cows in the Ohio Station herd were obtained. Three of these calves, Group I, were fed whole milk from cows receiving a ration with a nutritive ratio of 1:2; and three, Group II, were fed whole milk from cows receiving a ration with a nutritive ratio of 1:13. Whole milk was fed to make sure that no undesirable factor was removed by skimming. All the calves received a basal ration of alfalfa hay, corn meal, wheat bran, and linseed oilmeal. For three days after birth the calves were allowed to nurse their mothers. They were then moved to individual calf pens and fed warm whole milk twice a day, the amount fed depending upon the size of the calf and being increased until a maximum of 16 pounds a day was consumed. Hay and grain feeding usually started when the calves were between three and four weeks old. Hay was kept before them all the time; the amount of grain fed was determined by the amount cleaned up at the previous feeding. The calves were weighed weekly and measurements of the height at withers taken. The feeding period lasted six months.

Table 1 shows the average daily gain of each group compared with the average daily gain of normal Holstein heifer calves according to Eckles (Missouri Research Bulletin 36).

TABLE 1.—Daily Gains of Holstein Heifer Calves

Group	Calf	Birth weight	Final weight	Gain per day	Average daily gain
	No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
I High protein milk	351	100	404	1.66	
	352	95	397	1.66	1.65
	353	117	413	1.63	
II Low protein milk	356	100	391	1.59	
	368	85	374	1.57	1.60
	369	80	381	1.63	
Normal (Eckles)	....	90	349	....	1.42
Normal (Ohio Exp. Station)	....	90	360	....	1.48

The calves that were fed milk from the cows on the high protein ration made slightly better average daily gains than those fed milk from cows on the low protein ration. In view of the small number of animals used, however, no significance can be attached to this difference. The average daily gain in weight of each group was appreciably greater than that established by Eckles as normal and the average of the calves raised in the Ohio Experiment Station herd. While the normal figures of Eckles and of the Ohio Station herd are based on skimmilk feeding, it is felt that the comparison is justified in that the object of this study was to determine whether the feeding of milk from these two groups of cows would produce calves inferior to the usual normal animal. No group receiving whole milk from cows fed in the normal way was used in this trial, owing to a lack of heifer calves. As this work is to be continued it is planned to secure data from normal feeding that will be entirely comparable to the data already obtained.

TABLE 2.—Gains per 100 Pounds of Whole Milk Consumed

Group	Calf	Whole milk consumed	Gain per 100 pounds milk	Average gain per 100 pounds milk
	No.	*Lb.*	*Lb.*	*Lb.*
	351	2541	11.96	
I, high protein milk	352	2555	11.82	11.78
	353	2561	11.56	
	356	2504	11.62	
II, low protein milk	368	2359	12.25	12.04
	369	2458	12.25	

In order to illustrate the regularity of gain a growth curve for each calf is given in Figure 1, A. Without exception the calves in Group I grew more regularly than did those in Group II. The calves in Group II tended to lag at first when nothing but milk was fed, but as soon as they ate grain and hay freely they grew rapidly and regularly. This indicates some superiority of milk from the cows fed the high protein ration. On the basis of gain per 100 pounds of milk consumed, however, this advantage is not apparent (Table 2).

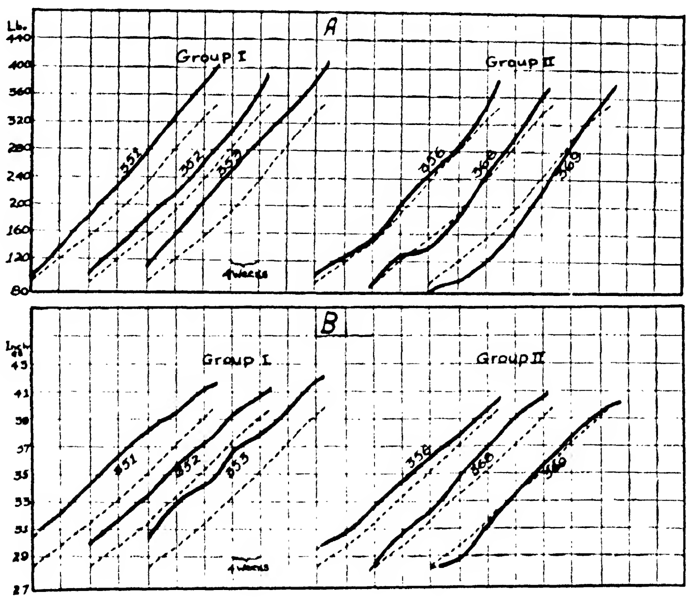

Fig. 1.—Calves in Group I were fed milk from high protein cows; in Group II, from low protein cows
A, Curves indicate growth in weight
B, Curves indicate growth of skeleton

The rate and regularity of skeletal development as measured by height at withers are illustrated in Figure 1, B. These curves show practically no difference in skeletal development in either group. The apparent superiority of the calves in Group I as compared with Eckles' normal may be explained by the fact that all the calves in this group were considerably higher at the withers at birth than those in Group II.

All the calves were in excellent physical condition thruout the experiment, except for some mild scours during the exclusive milk feeding period. At the end of six months they were photographed.

A typical representative of each group is presented in Figure 2. It will be seen from these photographs that the calves possessed all the characteristics desirable in animals of this age.

Fig. 2.—Typical calves from the two groups, 351 from Group I, high protein; and 356 from Group II, low protein

The practical conclusion to be drawn from this study is that cows may be fed rations extremely high or low in protein content without materially affecting the food value of the milk for raising calves. It should be borne in mind that no attention was paid to the economics of this problem and that under usual dairy herd conditions the whole milk method of raising calves is not recommended.

SANITARY MEASURES FOR BROODING AND PRODUCTION OF PULLETS

D. C. KENNARD

Brooding chicks on a commercial scale is now rapidly becoming a common practice. This is a logical outcome of recent nutrition discoveries. It is now possible to formulate a complete ration for growing chicks without their access to an outdoor range. Commercial methods naturally involve a greater degree of intensification, which in turn must be accompanied by more effective sanitary measures to guard against the menace of disease and intestinal parasites. This is accomplished in a commercial way for the most part by two important sanitary measures—all-mash feeding and brooding the chicks over wire.

Brooding chicks over wire has a variety of applications. The latest and most promising in many respects is to brood chicks in battery brooders. Such batteries are usually made up of compartments about 3 by 6 feet and arranged 3 to 5 tiers high. Each compartment may have an independent heating unit, or the batteries may be kept in a room where the proper temperature is maintained by forced air circulation.

The chicks are kept on wire screen so they never come in contact with the droppings. They eat and drink from clean receptacles attached to the outside of the battery cages and, as they have no chance of coming in contact with contaminated soil, it is obvious that the liability of exposure to disease and parasites is reduced to a minimum.

At present this method is mostly confined to the brooding of market broilers and the storage of chicks at hatcheries. The Ohio Experiment Station has used battery brooders successfully for experimental groups of chicks up to ten weeks of age during the past year.

Wire floor for colony brooder house.—A modification of this principle of brooding can be used by the practical poultry keeper for the portable coal-stove or oil-heated brooder house where it is difficult or impossible to maintain proper range conditions. A 10 by 12 foot brooder house screened to keep the chicks off the floor and away from the droppings is shown in Figure 1. This, with an outside sun parlor to keep the birds off the soil, undoubtedly offers the best insurance against disease, especially coccidiosis, and round worms. If tapeworm infestation is to be guarded against the

brooding quarters and sun parlor must be protected with fly screens so as to keep out all flies, since the fly is now regarded as the principal host or carrier of tape worms.

The suggested plan for screening a 10 by 12 foot brooder house can be adapted for houses of other dimensions except those that are round. If the house has a 12-foot front and is 10 feet wide the same plan is used except that the frames are about 2½ feet wide and about 1 foot longer and are placed endwise from front to rear instead of from side to side. The ½-inch square-mesh hardware cloth 30 or 36 inches wide can usually be obtained from the local hardware dealer for about 4 or 5 cents a square foot.

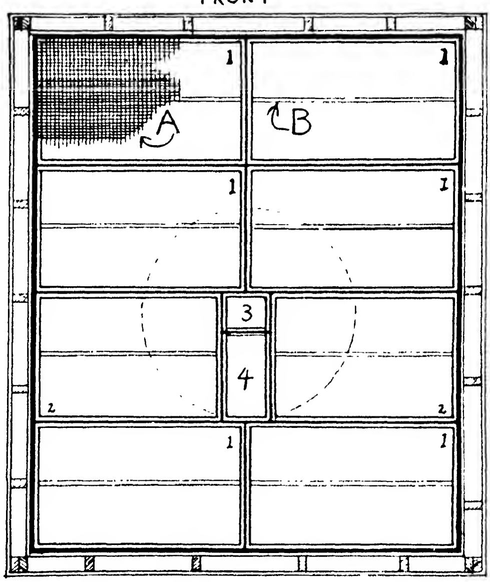

Fig. 1

Plan for screening a 10 by 12 foot coal stove brooder house

1. Floor frames about 3′ x 5′ with center support B to prevent wire from sagging.
2. Frames about 3′ x 4½′.
3. Frame about 1′ x 1′ for supporting stove, the exact size depending on the dimensions of the base of stove. Since the stove sets on this it need not be screened.
4. Frame about 1′ x 2′ to fill in the space just back of the stove. All frames made of 1″ x 6″ boards placed edgewise and covered with ½-inch square mesh hardware cloth. The center supports may be made of 1″ x 4″ pieces if desired.
5. The top inside edges of the frames are beveled and the frames spaced ⅜- to ½-inch apart, as indicated by heavy black line which surrounds each frame, so as to reduce area for lodgment of droppings. Likewise both corners of the top edges of the center supports are beveled to ⅜ to ½ inch in width for the same reason.

A sun parlor either open or closed is an important adjunct to the brooder house for confined chicks. In this they can enjoy the benefits of direct sunlight even tho they are denied the outdoor range. A desirable sized sun parlor for a 10 by 12 foot brooder house to accommodate 200 chicks is 5 by 9 feet. This can be provided by the use of three wire floor frames each 3 by 5 feet, placed endwise to the front or south side of the brooder house. For an open sun parlor this would be inclosed with 1-inch mesh poultry netting, or by fly screens if the chicks are to be protected from flies. For an inclosed parlor a glass substitute should be used that will permit a large proportion of the beneficial rays of direct sunlight to pass thru. The lower part of the sun parlor needs to be inclosed to prevent too much draft thru the wire floor and to keep out other chickens and animals. The inclosure should extend two to three feet above the floor on the sides exposed to prevailing winds, so as to provide the chicks as much comfort as possible to encourage them to spend a considerable amount of time outside; otherwise the full benefits of the parlor will not be realized.

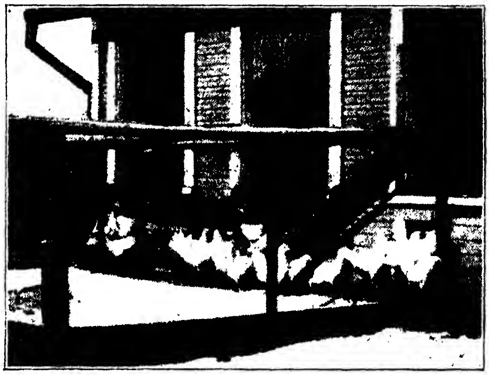

Fig. 2.—The sun parlor is an important adjunct to the brooder house

A further advantage of screening the floor is that it makes the best solution of the litter problem. Besides saving the expense sometimes involved in providing litter, the danger of using litter that may have an injurious effect on the chicks, as often happens, is eliminated.

It should be emphasized that the feeding requirements of chicks brooded on wire are more exacting than when they have access to the range; they must have a complete ration when denied the outdoor range.

Range method.—The use of an open range that is free from disease and parasitic contamination has been, and probably will continue to be, for the majority of poultry raisers the most practicable and perhaps the most effective way of raising chicks and pullets free from coccidiosis and internal parasites.

This requires that the brooder house be portable so that it may be moved to a new location each year, or oftener when a large num-

ber of chicks are to be raised. It is evident then that the open-range method is adapted only for those who desire to raise a comparatively small number of chicks and pullets where ample acreage is available to meet their range requirements.

But if the brooding of chicks is to be done by intensive methods, comparable to the development of incubation by the hatcheries, the outdoor range method fails in many ways to serve the purpose. It would seem that the brooding of chicks on wire in batteries or in brooder houses with the sun parlor annex, so they never touch the soil, offers the greatest promise.

Irrespective of the method employed, we must remember that it takes clean chicks to make clean pullets. Pullets handicapped by coccidiosis or internal parasites are almost invariably a losing proposition. No ration and no amount of skill in feeding and management will return a profit. Furthermore, to make matters worse, the low production is usually accompanied by a high mortality. Too many fail to raise clean chicks and then resort to treatment and remedies in their attempt to correct the result of faulty brooding. Success does not usually attend this procedure because clean pullets depend on proper preventive and sanitary measures during the brooding and summer range periods rather than on treatment or remedial measures afterwards.

Raising clean chicks and pullets means a constant fight for prevention of disease and internal parasites. The best and most dependable implements to win the fight are all-mash feeding; brooding the chicks on wire so they have no contact with soil and, if tape worms are a menace, under fly screen; or brooding the chicks in portable brooder houses moved each year or oftener to locations free of contamination and not frequented by older birds.

If clean pullets are to go into the laying house in the fall they must not only pass thru the brooding period clean but they must be maintained free of coccidiosis and intestinal parasites during the summer range period. Failing to realize this fact, it frequently happens that poultry raisers bring the chicks thru the brooding period in fine shape, then transfer the pullets to a contaminated range or where they come in contact with the older birds with the result that the pullets often go "all to pieces", so to speak, and all the benefits of the proper brooding are lost. No poultry keeper should take such a chance. This will require for summering pullets an exclusive range that is free from disease and parasitic contamination and entirely away from older birds. For roosting quarters on the range portable brooder houses or roosting quarters are necessary so they can be moved to new ground when necessary.

A GARDEN FOR CHICKENS

D. C. KENNARD

That green feed or its equivalent is essential for success with chickens is one of the few things on which all poultry keepers are agreed. What is best to grow for this purpose is a question that deserves more attention than it has received in the past.

Many poultry keepers now realize that growing and properly curing alfalfa, red clover, or soybean hay for use as a dried green feed for winter feeding is an essential part of the management of a successful poultry enterprise. Likewise the poultry garden should receive the same careful consideration.

Why the chicken garden?—A garden to supply an abundance of fresh green feed when the range fails during the latter part of the season, may determine the net profit of a flock for the year. Late summer and fall eggs are usually scarce and bring good prices because so many hens quit laying at this time, often because their range has been worn out or is inadequate. For late summer and fall egg production the importance of a garden to supply the necessary green feed to replenish the inadequate range is therefore self-evident. How long the range will hold out is always an uncertainty because this depends not only on the number of birds but the amount of rain from July to November. A frequent cause of failure to secure a profitable egg yield during late summer and fall is that the poultry keeper does not have a chicken garden to supply the needs of his flock. Early spring is the time to prepare for such a garden.

What to plant for use as fresh succulent green feed may be varied so as to serve the purpose of the individual poultry keeper. Red clover is one of the first sources of green feed available in many sections. This can be followed by the garden crops. In the rather extensive culture and use of crops for succulent green feed at the Ohio Station's poultry plant, early cabbage, swiss chard, and New Zealand spinach have proved well adapted for the purpose. For variety and certainty of crop it is well to plant about equal areas of each. All three of these crops are heavy producers and a surprisingly large quantity of the choicest green feed can usually be secured from a comparatively small area of suitable garden soil.

Cabbage and swiss chard are common garden crops, but many poultry keepers may not be familiar with New Zealand spinach.

New Zealand spinach produces a luxuriant growth of vines and a heavy foliage of fleshy, tender, dark green leaves. The vines are two to three feet long, branch in all directions, and cover the ground with a dense growth (Fig. 1). After the vines are cut they are followed by another growth, so that production continues. Chickens greatly relish the spinach and if it is cut in ½-inch lengths by passing thru a clover cutter they will eat most of the large fleshy stems as well as the leafy portion.

Culture.—The swiss chard and New Zealand spinach should be planted as soon as the ground becomes workable in early spring. The seeds are sowed in rows spaced 1½ feet for hand culture and 2 to 2½ feet for horse culture. The seeds are planted 1 to 2 inches apart in shallow trenches and covered with about 1 inch of soil. A frequent mistake is to cover the seeds too deep. A hand drill can be used to advantage for planting the chard but owing to the hulls on the spinach seeds it is better to plant them by hand.

Fig. 1.—The chicken garden yields succulent green feed Early cabbage (left), New Zealand spinach (middle), Swiss chard (right)

New Zealand spinach seeds require treatment with hot water to soften the husk and insure satisfactory germination. This is done by pouring just enough water heated nearly to the boiling point to cover the seeds and then letting them soak and gradually cool 4 to 6 hours before planting.

For early cabbage there are a number of suitable varieties such as the Copenhagen Market, Early Jersey Wakefield, All Seasons, and others to choose from. The cabbage plants should be ready to plant as early as the season and condition of the soil will permit.

Following this some of the late varieties may be planted for use in December and January.

Mangels, stock beets, and sugar beets are succulent feed but do not serve the purpose of green feeds because they do not possess the vitamin properties of the leafy green feeds.

A yearly green feed rotation for poultry.—The most successful poultry keeper will have no missing links in his yearly rotation for green feed. Beginning with November early cabbage, swiss chard, or New Zealand spinach may be used until December. Late cabbage may be fed until January. Green feed in succulent form is not suitable to feed when the temperature in the poultry house goes much below freezing. Beginning with November or even before and until May the use of dried green feed in the form of high quality immature-cut alfalfa, red clover, or soybean hay seems to be the best solution of the green feed problem. After April or May dandelions, red clover, and the blue grass or red clover range can be depended upon until July or August when the chicken garden of early cabbage, swiss chard, or New Zealand spinach comes in to make the final connecting link for the completion of the year.

SPRAYING A YOUNG ORCHARD—COST OF LABOR AND MATERIAL

C. W. ELLENWOOD

In the Bimonthly Bulletin for March-April, 1924, an article was presented on "Some Spraying Costs of Labor and Material". The data in that article were collected in bearing orchards of different ages and sizes. Since the data taken each year since then correspond very closely to the results published in that article, further report on these particular orchards will not be made at this time. The prices used in calculating labor and materials have varied but little. These records are kept to determine the amount of material required to spray a tree, and the cost of spraying.

The present article is concerned with data taken from the spraying records of an orchard under bearing age. The orchard was planted in 1922 and contains 361 trees of the Wealthy, Baldwin, and Stayman varieties. The records under consideration here are for four years, 1924 to 1927, inclusive. The trees were not sprayed in 1922 and but once in 1923.

Records were also kept on another orchard of 435 trees of the same age (planted in 1922) with results similar to those here described.

In 1924 the trees were sprayed with a hand power barrel sprayer equipped with a bamboo pole and nozzle. In 1925 and succeeding years they were sprayed with a power outfit equipped with guns.

THE SPRAY PROGRAM

The spray program used in the orchard from 1924 to 1927 is given here. Arsenate of lead, when included in the program, was used at the rate of 1¼ pounds (powder) to 50 gallons of solution. Nicotine sulfate, when included, was used at the rate of 1 to 800 (one quart to 200 gallons of solution).

Spray treatment for 1924 included two applications: the first, April 11, a dormant application of liquid lime-sulfur at the rate of 1 gallon to 7 of solution; the second, June 2, liquid lime-sulfur 3 gallons to 50 of solution plus arsenate of lead.

In 1925 four applications were made: the first, or dormant spray, April 7, was lime-sulfur 12 pounds to 50 gallons; second, May 19, 3 pounds of dry lime-sulfur to 50 gallons plus arsenate of lead and nicotine sulfate; third, June 27, a duplication of the second application; fourth, July 22, 3 pounds dry lime-sulfur to 50 gallons of solution plus arsenate of lead.

Four applications were made in 1926: first, April 29, dormant, dry lime-sulfur 12 pounds to 50 gallons solution; second, May 11, liquid lime-sulfur 1 gallon to 40 of solution; third, June 2, dry lime-sulfur 3 pounds to 50 gallons solution, plus arsenate of lead; fourth, July 30, liquid lime-sulfur 1 gallon to 80 of solution plus arsenate of lead.

Five applications were made in 1927: first, April 6, dormant, oil 6 gallons to 200 gallons solution; second, April 22, pre-blossom, dry lime-sulfur 3 pounds to 50 gallons solution; third, May 12, dry lime sulfur 2 pounds to 50 gallons solution plus arsenate of lead and nicotine sulfate; fourth, June 2, dry lime-sulfur 2 pounds to 50 gallons solution plus arsenate of lead; fifth, July 22, duplication of fourth application.

COMPUTATION OF COSTS

In computing costs labor is allowed 35 cents an hour, a team 35 cents an hour, which represents the actual cost at Wooster. From 40 to 50 cents an hour is charged for power sprayers, depending on outfit used. Materials are valued at the current prices paid for

them. With the exception of the dormant sprays and where nicotine is included the charge for labor and machine exceeds the charge for materials.

TABLE 1.—Cost of Spraying Young Apple Trees—Number of Applications and Amount per Tree

	1924	1925	1926	1927
Age of trees	3	4	5	6
Number of applications	2	4	4	5
Total amount per tree for season, gallons	0.8	3.9	4.6	7.8
Total cost per tree for season, dollar	0.028	0.127*	0.083	0.1793†
Method of application	Hand	Power	Power	Power

*One application nicotine sulfate. †Two applications nicotine sulfate.

COMMENTS ON THE PROGRAM

The program followed in any particular year does not indicate a preference for either dry or liquid lime-sulfur. Convenience and stock on hand decided whether the dry or liquid form should be used. The cost of the two forms of lime-sulfur was the same for the dormant spray, but the liquid cost a little less for the summer sprays.

Fig. 1.—Thoroly spraying both sides of the rows

On account of red bug and European red spider mite, oil was used as a dormant spray one year out of the four. When aphids were present in large numbers nicotine sulfate was used. If there were indications that there might be an infestation by foliage eating insects in late summer a spray containing arsenate of lead was applied in July. In 1927 apple scab was a serious menace, making a pre-blossom spray necessary.

The spray program outlined is not set down as a model. It is merely the program which good orchard practice seemed to demand in the handling of this particular orchard from year to year. An attempt was made to keep the foliage free from serious disease or insect attacks. This was accomplished and the trees made good vigorous growth each year. Workers reporting on various spray control measures agree that thoroness of application is of prime importance in securing good results.

It is well to note that the fruit produced in this orchard in 1927, 6 years from planting, just a little more than paid for the spraying costs for that year.

The amounts of material per application in any year varied with the purpose of the spray and the amount of foliage on the trees. In an orchard of bearing age the dormant spray and the first after-blossom spray usually require the most material per tree. The corresponding sprays in pre-bearing orchards generally require the most material. Severe infestations of aphids or some other pest may require the use of more than the average amount.

The records of this orchard show that the trees at 3 years from planting required an average of .4 gallon per application per tree; at 6 years from planting nearly 1.6 gallons. Referring to the data for Orchard E, page 61 of the March-April, 1924 Bimonthly Bulletin we find that trees 9 years from planting required an average of 4 gallons per tree per application.

DISTANCE OF PLANTING SWEET CORN TO INCREASE YIELDS

ROY MAGRUDER

An experiment was started in 1924 to determine the effect of different distances of planting and methods of grouping upon (1) number of ears per plant, (2) number of marketable ears per acre, (3) average size of ear, and (4) total weight per acre.

Early Adams variety of corn was grown in 1924, 1925, and 1926 at the Washington County Truck Experiment Farm and at Wooster in 1925. Altho not a sweet corn, it is extensively grown in the Marietta truck crop district and has a medium size plant and ear comparable to that of other early varieties grown in that district. Stowells Evergreen, a variety with large plant and ear and commonly planted for the canning factory, was grown in 1926 at Wooster.

The Marietta soil is a sandy loam well supplied with organic matter and of medium fertility. In 1924 and 1925 the fertilizer treatment consisted of 8 to 10 tons of manure, 400 pounds of 16 percent superphosphate, and 160 pounds of sulfate of ammonia per acre. In 1926 the chemical fertilizer was raised to 1000 pounds superphosphate, 400 pounds of sulfate of ammonia, and 200 pounds of muriate of potash.

At Wooster the soil is a silty loam, more retentive of moisture and naturally more fertile than the Marietta soil. It received an annual acre application of 10 to 15 tons of manure, 500 pounds of 16 percent superphosphate, and 160 pounds of nitrate of soda.

EFFECT ON AVERAGE WEIGHT OF EAR

There was very little increase in size of ear of Early Adams after about 400 square inches per plant was reached, indicating that this is near the maximum area for this variety. Stowells Evergreen maintained a fairly steady increase in size of ear to the greatest distance used, indicating that its maximum area under 1926 conditions was greater than 630 square inches per plant. With the same number of plants per acre but grouped into 1, 2, and 3 plants per hill, there was practically no change in size of ear.

In some recently reported Iowa work they found that under their conditions the average size of ear increased very little after 500 square inches per plant was reached, for both Country Gentleman and Stowells Evergreen. Drought during the "filling" period of 1926 reduced the average size of ear of Country Gentleman about 8 percent below that of 1925.

EFFECT ON NUMBER OF EARS PER PLANT

The average number of ears per plant on Early Adams appeared to increase until about 425 square inches per plant was reached. Different groupings of the same number of plants per acre seemed to have no consistent influence on the number of ears per plant. The number of ears per plant of Stowells Evergreen increased steadily to the greatest area given, so it appeared that the maximum area for this variety in 1926 was greater than 630 square inches.

The 1925 results bring out the importance of favorable growing conditions upon the number of ears per plant and consequently upon the number per acre. Seed from the same lot was used at Marietta and Wooster, but the number of ears per plant in the closer planting distances was 30 to 40 percent greater at Wooster, where the soil is more fertile and holds moisture better.

Country Gentleman in two years of the Iowa work with good growing conditions showed a slight increase in number of ears per plant after the area per plant reached 500 square inches. In the third year, which was a dry one, there was a steady increase up to the maximum area used, demonstrating that during dry years corn plants require more area to produce the maximum number of ears per plant than during years of normal rainfall.

EFFECT ON NUMBER OF MARKETABLE EARS PER ACRE

It is the custom to plant Early Adams corn in the Marietta district in 36-inch rows with 3 plants in a hill and the hills 34 inches apart in the row. This spacing, therefore, is used as a basis on which to calculate the percentage increase from the best yielding distance.

TABLE 1.—Largest Number of Marketable Ears for Each Test and Percentage of Increase Over Usual Planting Distance

Year	Place	Planting distance	Ears per acre	Increase over 36—3—34
			No.	*Percent*
1924	Marietta	30 in. rows 2 plants 15 in. apart	17,061	61
1925	Marietta	30 in. rows 2 plants 20 in. apart	18,189	43
1925	Wooster	30 in. rows 2 plants 15 in. apart	27,627	69
1926	Marietta	30 in. rows 2 plants 15 in. apart	16,698	14
1926*	Wooster	34 in. rows 2 plants 20 in. apart	13,909	30

*Stowells Evergreen variety.

Altho the number of ears per plant is reduced by close planting, the closest plantings of Early Adams gave the largest number of marketable ears per acre 3 out of 4 trials as shown in the above table. The largest numbers of ears per acre of Stowells Evergreen was obtained from 34 inch rows with 2 plants every 20 inches.

It has been pointed out that the size of ear decreased as the number of plants increased, and, as the distances which gave the largest number of marketable ears were also those with the largest number of plants per acre, we would expect that the size of the ear would be relatively small. Such was the case in these experiments. The combination of medium size and large number was obtained with the Early Adams variety from 30-inch rows and averaged 300 square inches per plant. Stowells Evergreen gave the best results with 340 square inches per plant.

EFFECT ON PERCENTAGE OF FIRST GRADE EARS

Only first grade ears were harvested from the Early Adams tests, but with Stowells Evergreen everything accepted by a canning factory was pulled. The first grade ears were later graded

out. There was very little increase in percentage of first grade ears of Stowells Evergreen after the area per plant reached 408 square inches, either on a basis of number or weight.

Under Iowa conditions the increase in percentage of first grade ears for both Country Gentleman and Stowells Evergreen was slight after 440 square inches per plant was reached.

EFFECT ON WEIGHT PER ACRE

With the Early Adams variety the largest yield was obtained from the distance containing the largest number of stalks per acre, 2 out of 4 tests, as shown in the following table:

TABLE 2.—Largest Weight of Green Corn for Each Test and Percentage of Increase Over Usual Planting Distance

Year	Place	Planting distance	Weight per acre	Increase over 36—3—34
			Tons	*Percent*
1924	Marietta	30 in. rows 2 plants 15 in. apart	4.5	45
1925	Marietta	30 in. rows 2 plants 20 in. apart	5.4	35
1925	Wooster	30 in. rows 2 plants 15 in. apart	7.9	61
1926	Marietta	34 in. rows 3 plants 34 in. apart	6.1	less than 1%
1926*	Wooster	34 in. rows 2 plants 20 in. apart	6.3	19

*Stowells Evergreen.

No adequate explanation is available for the result obtained in 1928 at Marietta. The increases obtained for the other three tests are quite remarkable and what might be expected under average conditions with this variety. The arrangement of the same number of plants per acre into 1, 2, or 3 plants per hill seemed to have no consistent effect upon yield.

Country Gentleman in Iowa gave largest yields with an average of 441 square inches per plant 2 years out of 3. With a shortage of moisture 588 square inches per plant produced the largest yield. One year's work indicated that plants in hills yielded more than in drills.

Under New York conditions in 1927, Early Evergreen sweet corn produced largest yields when grown 4 plants to the hill with the hills 36 inches apart each way. There was practically no difference between the yields of hilled and drilled corn.

Golden Bantam, a small second-early variety, was also grown in the New York tests. The largest tonnage per acre was obtained from rows 24 inches apart with plants drilled about 6 inches apart in the row, altho the yield was not much larger than that obtained from 4 plant hills 30 inches apart each way.

In connection with yield, it is interesting to note that Ira Marshall of Hardin County, Ohio, the world's champion field corn grower for three successive years, plants in 34-inch rows with an average of $3\frac{1}{2}$ plants in hills 33 inches apart in the row. His high yields have brought his growing costs down to about 20 cents per bushel.

CONCLUSION

Since costs are largely based upon production per unit area, the possibility of increasing production per unit area is important. Because of the variability among different farms in the factors listed below, each grower will of necessity be required to do some experimenting on his own soil to determine the proper distance. Some of the factors that should be considered in attempting to determine the proper distance of planting for largest yield are:

1. Size of plant of the variety to be grown. Smaller plants may be grown more closely than larger types.

2. Fertility of soil. More fertile soil will maintain a larger number of plants per given area than poor or infertile soil.

3. Supply of moisture. Since it determines the availability of the plant food it reacts in the same way as fertility. A planting rate suitable for average conditions is usually too thick during a dry season.

4. Purpose for which the crop is grown. If large size of ear is desired the distance of planting should be greater than if only medium size, as for canning, is necessary. If size is not as important as quantity, then the maximum yield can be obtained by closer planting.

A NOTE ON LIGHT VERSUS HEAVY PRUNING OF YOUNG PEACH TREES

J. H. GOURLEY

Various elements enter into consideration in the pruning of any kind of fruit plants; but more particularly the kind of pruning, the amount of pruning, and the time of the operation. With the apple the present tendency is toward lighter pruning while the trees are young and somewhat heavier pruning as they become old, than was the custom in Ohio a decade ago. With the peach, however, there

is still a tendency toward rather heavy pruning during the early years as well as after the trees have reached full maturity.

Careful observation has convinced some growers that the young peach tree "matures" and begins fruit production sooner and that a larger bearing surface will be developed if heavy cutting back of the branches is avoided. The chief pruning according to these growers, therefore, should consist in a light thinning out. However, many others adhere to the more usual practice of rather heavy cutting during the early life of the peach.

With this diversity of practice there seemed to be further need of experiments designed to show the merits and demerits of light and heavy pruning of young peach trees. Consequently a rather simple comparison was laid out in conjunction with some fertilizer experiments that were in progress with the Catawba Island Orchard Co., of which Mr. V. H. Davis is manager. In this large peach section the prevailing practice has long been to prune both young and old peach trees very heavily. As a result the average yield per tree is comparatively low.

The orchard in which this work is being done is of the Elberta variety, planted in 1922. The fertilizer experiment includes 22 rows of 10 trees each. The first 11 rows, or Series A, constitute all the treatments involved and the second 11 rows, or Series B, are a replication of Series A. The first two trees in each row were pruned lightly for 1926 and 1927; the pruning consisted of a thinning out rather than a heavy cutting back of the branches. The third tree in each row has been cut back rather severely, in keeping with the usual practice of the community. According to the latter method, the smaller, outer limbs are all removed, the centers are opened, and an attempt is made to cut the tops to a uniform, flattened head.

The average weight of the material pruned from the trees in 1925 was as follows:

Row 1	Light pruning	3 pounds
Row 2	Light pruning	3 pounds
Plot 3	Heavy pruning	7 pounds

While the weight of the prunings was not recorded in 1926, it was in much the same proportion.

YIELD

The increased pruning of Row 3 resulted in a decrease of crop regardless of the soil treatment each season, as well as a noticeable reduction in size of trees.

The following figures give the average yield per tree as recorded each year.

TABLE 1.—Average Yield per Tree of Lightly Pruned and of Heavily Pruned Trees

No.	Method of pruning	1925 Lb.	1926 Lb.
20	Lightly pruned trees, Series A	37.8	34.4
22	Lightly pruned trees, Series B	42.0	45.2
	Average	40.0	40.1
11	Heavily pruned trees, Series A	28.9	16.6
10	Heavily pruned trees, Series B	32.9	28.3
	Average	30.8	22.2
	Percentage increase of light pruned trees	30%	80

The reduced yield is so impressive, when a large area of trees is considered, as to warrant a change in the pruning practice of young trees for that district. On the other hand, mature peach trees should be heavily pruned in order to stimulate the type of wood that is desired to suppress in the young trees.

A proper pruning practice of itself is not sufficient to maintain high and uniform yields of peaches, but should be accompanied by systematic tillage, green manuring, and the use of either ample quantities of stable manure or chemical fertilizers. Furthermore, the production of clean, sound fruit is also dependent upon a proper and thoro spray program.

TRUCK MOVEMENT OF OHIO APPLES

CHAS. W. HAUCK

Commercial production of apples in the United States during the ten years 1917-1926 averaged about 4/5 of a bushel per capita, but Ohio during this same period produced annually a little less than 2/5 of a bushel per capita. At this rate the commercial production of apples in Ohio is barely sufficient to supply 2¾ millions of people, or less than half the present population of the State. During the years 1918-1926 annual carlot shipments from Ohio points averaged only 753 cars, or 17 percent of the commercial crop.

The remaining 83 percent was marketed locally by other means, including hauling by trucks and wagons, sale direct to consumers at roadside markets, conversion into by-products, etc. It is significant that with a commercial production about equal to that of Missouri, Colorado, or West Virginia, Ohio ships annually 700 cars by rail while Missouri ships 2100, Colorado 2900, and West Virginia 3900. Obviously, Ohio is in a deficit area as regards apple production, a distinct advantage from a marketing standpoint.

It does not follow, however, that every section of the State is so fortunately situated. Some of the counties that are the heaviest apple producers are located in the less densely populated regions of the State. These sections have to look for a part of their markets in areas which, tho within or near Ohio, can be reached economically only by rail. Naturally we find much larger proportions of the apple crops of those counties being shipped by rail than in the sections within hauling distance of the larger cities and industrial regions. In producing areas adjacent to the larger cities the rail movement of apples is negligible.

A very small proportion of the apple crop of central and northern Ohio moves by rail. The non-agricultural population in these sections is large in proportion to the local production of apples. On the other hand some of the counties in the southeastern part of the State ship as much as three-fourths or more of their commercial crop by rail.

Jackson County, altho its apple production normally is fairly large and its population small, nevertheless lies within trucking distance of several large consuming centers in the central and southwestern parts of the State and as a result about two-thirds of the apple crop of that county is trucked to market. Washington, Meigs, and Gallia Counties, among the largest apple producers in the State, all lie in the relatively sparsely populated region along the Ohio-West Virginia border. Their near-by markets are small. Local consumers are not numerous enough to consume all their output, hence considerable quantities have to be shipped by rail. Lawrence County, the largest apple-producing county in Ohio, moves approximately one-half of its crop by rail and one-half by other means. These proportions doubtless would resemble those in the other southeastern counties were it not for the location of Huntington, W. Va., within trucking distance of the orchards of this county. Recent highway improvements also have made certain of the West Virginia coal fields accessible by truck, and these industrial regions consume considerable quantities of apples from

this section. Huntington is said to consume 40,000 barrels annually, or about one-seventh of the commercial crop of Lawrence County in a normal season.

Two factors, then, appear to be mainly instrumental in determining the amount of fruit that is shipped by truck: (1) the quantity of apples produced in the section; and (2) the density of the population within trucking distance of the section. A third factor also, the quality of the fruit, since it has a very material bearing on the readiness with which sales may be made, may exert considerable influence on the amount sold locally. This phase of the subject merits serious consideration but has no place in the present discussion. Suffice it to say, that uniformly good quality in the grade and pack of Ohio apples cannot fail to be reflected in better marketability of the fruit. Anything that will help to increase the amount sold locally should enlarge the profits of the Ohio grower. When shipped to distant markets costs are increased and greater competition must be faced.

TABLE 1.—APPLES, Production and Shipments from 23 Ohio Counties

County	Harvested 1924*	Carload shipments†	Portion of commercial crop shipped‡	
			By rail	By truck and other means
	Bu.	*No.*	*Pct.*	*Pct.*
Ashtabula	89,524		10—15	85—90
Athens	151,603	78	50—60	40—50
Belmont	150,953		10	90
Clermont	149,280		Less than 10	More than 90
Columbiana	211,168	82	40—50	50—60
Delaware	34,372		Practically none	Almost 100
Erie	69,055	7	Practically none	Almost 100
Fairfield	79,783		Practically none	Almost 100
Gallia	170,783	148	65—75	25—35
Geauga	94,251		Practically none	Almost 100
Jackson	80,750	45	30—40	60—70
Lake	90,007		Practically none	Almost 100
Lawrence	740,263	§	50 or more	50 or less
Lorain	117,032	3	Practically none	Almost 100
Mahoning	105,119	10	Practically none	Almost 100
Meigs	168,992	61	85 or less	15 or more
Ottawa	105,596	41	20—30	70—80
Ross	169,772	103	40	60
Sandusky	84,225	11	Practically none	Almost 100
Scioto	94,231		5	95
Stark	127,386		Practically none	Almost 100
Washington	215,075	154	85	15
Wayne	123,104	8	Less than 5	More than 95

*1925 Census of Agriculture.
†Seven-year average 1920-1926.
‡Present conditions, estimated on the basis of personal interviews with growers, shippers, and dealers.
§Shipments from Lawrence County averaged 17 cars exclusive of shipments from W. Va. points, which were not reported separately prior to 1926. In 1926 Huntington and Guyandotte, W. Va. shipped 316 cars of Ohio apples.

AN INDEX OF OHIO'S GROSS CASH INCOME FROM AGRICULTURE

V. R. WERTZ

Agriculture has, for some time, been in need of an adequate measure of her economic status. This need has been felt very keenly, especially since the downward trend of the income to this industry following 1919 and 1920. The first measures of the economic well-being of agriculture were price indices i. e. index numbers showing the variation in prices of farm products. It is scarcely necessary to say that series representing changes in the prices of products which farmers have to sell do not depict accurately the economic condition of the farming industry, for the reason that income is the result of two variables—quantity sold as well as price.

The index given in the Table 1 is an index of the gross cash income to the Ohio agricultural industry. This series is not, of course, a complete measure of the well-being of Ohio's agricultural industry, but a measure of the amount of money income to this industry from the sale of farm products. To secure a complete measure of the economic well-being of the agricultural industry of the State it will be necessary to calculate two additional series, one representing the total gross income to the agricultural industry of Ohio i. e. the value of farm products used on the farm as well as the value of those which are sold, and the other representing the amount expended for business purposes.[1]

The index numbers which appear in Table 1 are calculated from the estimated monthly gross cash income from the sale of sixteen of Ohio's principal agricultural products[2]; hogs, cattle, calves, sheep, whole milk, butterfat, wheat, corn, oats, rye, barley, buckwheat, poultry, eggs, tobacco, and wool. It is estimated that the income from these sixteen commodities will comprise approximately 90 percent of the total agricultural income for the State.

The highest income for the eight years here considered was that of 1920. In that year the estimated income stood 54 points above the average income for the three years, 1924, 1925, and 1926

[1]These latter two series are now being constructed and will later be made available.

[2]An index of the estimated gross cash income for the state from meat animals, dairy products, grains, poultry and eggs, tobacco and wool, and for the total of these five groups will be available currently hereafter, on or before the 15th of each month, for the preceding month.

(the base period). The lowest gross cash income to the Ohio agricultural industry since the war was in 1922, and the highest in 1926. The year 1927 is striking because it brought to a halt the gradual upward trend in gross cash income, which had taken place since 1922. The preliminary estimate, which has just been made, places the 1927 income 9 percent below the average for the three basal years. It will be observed that the income from each of the groups in 1927, with the exception of dairy products, which stands at practically the same figure as in 1926, shows a decrease from 1926. The major portion of the decline in the 1927 income was in the last six months of the year.

TABLE 1.—An Index of the Gross Cash Income from Ohio's Agricultural Industry, 1920-1927

(Av. 1924, 1925, and 1926=100)

Year	Meat animals	Dairy products	Grains	Poultry and eggs	Tobacco	Wool	Total
1920	158	147	168	119	228	144	154
1921	89	97	78	85	189	53	90
1922	97	91	72	80	82	90	88
1923	90	116	87	83	90	110	95
1924	90	103	96	90	95	102	95
1925	97	97	95	103	103	103	98
1926	113	99	109	107	102	95	108
1927*	84	99	92	99	73	93	91

*Preliminary estimates for 1927.

The two groups in which the main decrease in income occurred were meat animals and grains. The greatest decline in the annual income was that of hogs. This accounts for the greater part of the decline in the income from meat animals since approximately two-thirds of this income is from the sale of hogs. This decrease was also due to a falling off in the volume of sales as well as from declining hog and sheep prices. The volume of meat animals sold fell off approximately 19 percent from 1926 to 1927, while the price level declined approximately 10 percent.

The income from grains, which stood 9 points above the three-year average in 1926, fell to 8 points below this average in 1927. The decline in grain income was due mainly to a drop in the income from two of the most important grains, corn and wheat. As in the case of the decline in the income from meat animals, the grain income fell in 1927 because of a drop in both quantity and prices of grains sold. The Ohio grain price level fell three points in 1927 from what it was in 1926, and the grain sales, due mainly to smaller production in 1927, fell 15 points.

CORN-HOG RATIO IN OHIO

C. R. ARNOLD

Since approximately three-fourths of the total feed cost of producing pork in Ohio is normally for corn, the ratio between the value of a bushel of corn and that of a hundred pounds of live pork is quite important to the hog producer and hog feeder. This is known as the corn-hog ratio and is the number of bushels of corn that a hundred pounds of pork (live weight) will buy. During the last seven years this ratio has varied from 7.6 in June 1923 to 20.9 in June 1926. It is considered profitable to feed hogs when the ratio is above 11.7, the average for the last 17 years. The margin in 1926 was good, varying from 16.2 to 20.9, with an average of 18.9. In 1927 the price of hogs came down and poor prospects for the growing crop caused an advance in the price of corn. The ratio dropped to 9.4 in June, 1927, or less than half the ratio in January. It is interesting to note the regularity with which the wide and narrow margins follow each other (Fig. 1).

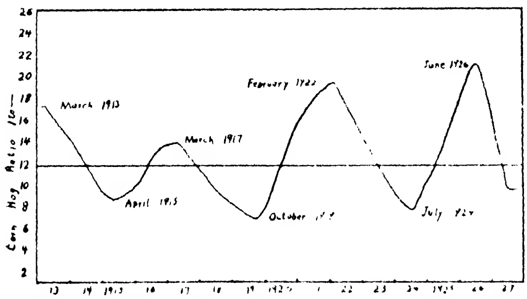

Fig. 1.—High and low points in the corn-hog ratio, 1913-1927

TABLE 1.—Corn-Hog Ratio in Ohio

Number of bushels of corn which were equal in value to 100 pounds of hogs (live weight)

	1921	1922	1923	1924	1925	1926	1927	Average
January	13.4	16.3	11.9	9.7	8.1	18.7	19.3	13.9
February	14.8	19.3	11.1	9.2	8.0	19.5	18.7	14.4
March	17.0	18.6	10.4	9.4	10.4	20.0	19.3	15.0
April	15.4	16.6	10.0	9.5	11.4	20.0	18.5	14.5
May	13.9	16.1	9.1	9.0	10.0	19.8	14.1	13.1
June	12.7	15.7	7.6	9.6	9.7	20.9	9.4	12.2
July	14.8	15.8	8.0	7.5	11.4	18.8	9.7	12.3
August	16.1	14.0	8.3	8.3	11.6	16.2	9.9	12.1
September	13.1	13.0	9.5	8.1	12.2	17.5	10.1	11.9
October	13.9	13.9	8.9	8.4	14.8	17.2	11.5	12.7
November	16.8	12.3	8.4	8.5	18.0	18.6	11.7	13.5
December	16.8	11.8	8.7	8.0	18.3	19.8	10.8	13.5
Average	14.9	15.3	9.3	8.8	12.0	18.9	13.6	13.3

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

From a price standpoint the year 1927 had a rather bad ending for the Ohio farmer. Hogs, which started the year at the same price as a year previous, ended the year at an average farm price of $8.30 as compared to $11.50 for December in 1926. November and December declines in milk prices, in some of the leading cities, also helped to depress the price level for December. Beef cattle prices were much higher than a year ago, but beef is a smaller source of income to the Ohio farmer than hogs. Not only in price but also because of volume did the Ohio farm income suffer during the latter half of the year. The wheat crop of 1927 was 107,720,000 bushels as compared with 147,231,000 bushels in 1926, while the Ohio corn crop for 1927 averaged 32.5 bushels per acre as compared with 41 in 1926.

For the year as a whole the weighted index of Ohio farm products prices averaged 147 as compared with the all-commodity index of 149, a decline as compared with the previous year of 8 points in the former and 5 points in the latter.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Non-agricultural products U. S.	Farm products prices U. S.	Ohio Farm wages	Ohio farm real estate	Farm products prices Ohio
1913	102	....	105	100	104	100	104
1914	100	100	97	102	102	102	105
1915	103	101	101	100	103	107	106
1916	100	114	138	117	113	113	121
1917	131	129	182	176	140	119	182
1918	188	160	188	200	175	131	203
1919	290	185	199	209	204	135	218
1920	210	122	241	205	237	159	212
1921	130	203	167	116	164	134	132
1922	152	197	168	124	145	124	127
1923	156	214	171	135	166	122	134
1924	152	218	162	134	165	118	133
1925	161	223	165	146	165	110	159
1926	154	228	161	136	170	105	155
1927	149	....	....	....	....	....	147
1927							
January	150	232	155	126	169	....	145
February	149	231	156	127	....	....	145
March	148	234	153	126	....	99	144
April	147	230	151	125	172	....	144
May	147	230	150	126	....	....	145
June	146	230	150	130	....	....	147
July	147	228	151	130	174	....	147
August	149	231	151	132	....	....	149
September	152	233	152	140	....	....	149
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Ohio Agricultural Experiment Station

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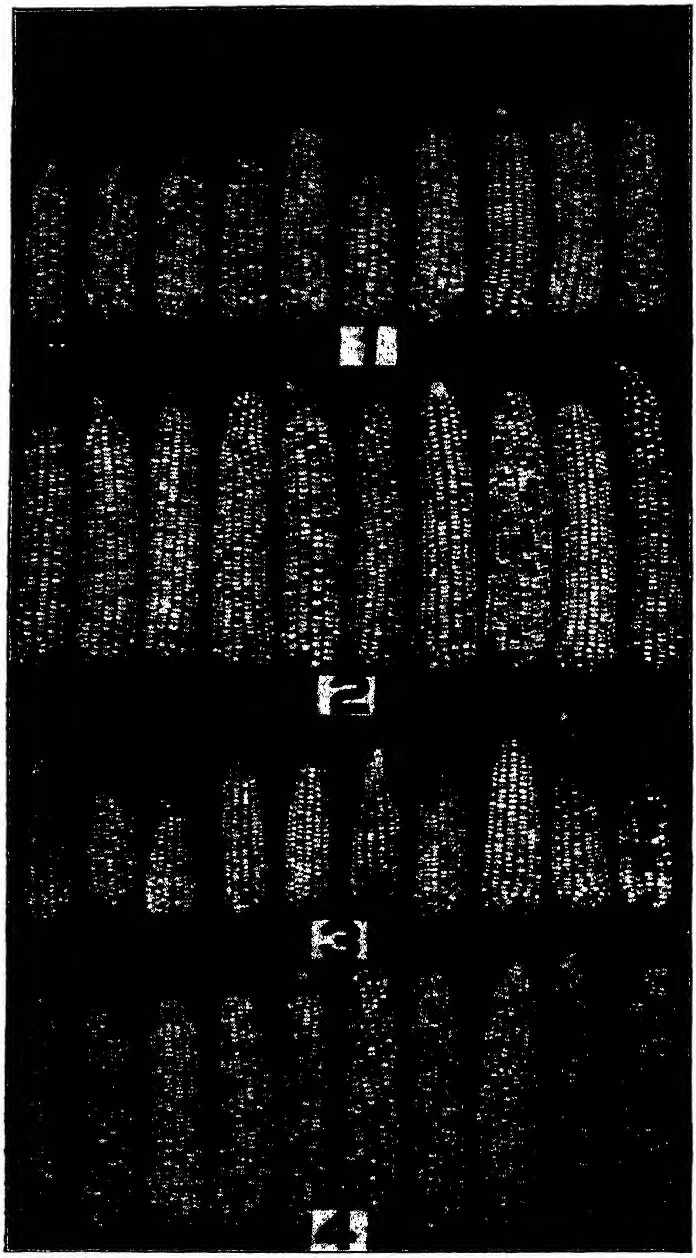
OHIO AGRICULTURAL EXPERIMENT STATION

Wooster, Ohio, U. S. A.



Randon ears of Burr Leaming corn, crop of 1927

1. Planted May 13, No treatment.
2. Planted May 13, 8 tons manure, 225 pounds 0-16-0 broadcast, 200 pounds 3-12-4 in hill.
3. Planted June 3, No treatment.
4. Planted June 3, 8 tons manure, 225 pounds 0-16-0 broadcast, 200 pounds 3-12-4 in hill.

FERTILIZERS SPEED GROWTH AND INCREASE YIELD OF CORN

ROBT. M. SALTER AND R. W. GERDEL

The fact that the development and maturity of a crop may be hastened or delayed by soil treatment is not new. On the other hand, the relative value of manure and fertilizers, and especially the effects of different methods of applying fertilizers to corn, in hurrying the crop along to maturity are not generally understood.

Any practice which will help the corn crop to make better use of the time at its disposal has practical importance. In the first place, by hastening maturity, a later and higher yielding variety may be grown. In the second place, in seasons or on soils making late planting necessary, the adoption of such practices should help in getting the crop out of danger before frost. There is also the possibility that the corn borer may become so destructive in certain areas that late planting will be advisable as a means of reducing infestation. Under such conditions, practices that will force the crop to do its best during the remainder of the season will be most valuable.

The best yield of corn is usually obtained by choosing a variety which, when planted at the normal time, will utilize practically the full growing season but will mature safely before frost. On the Experiment Station farm at Wooster corn is usually planted around May 15 to 20, with the average date of the first killing frost about October 5. Varieties such as Clarage and Medina Pride seem to be best adapted. In a 9-year corn variety test Medina Pride has led all varieties with an average of 70.1 bushels per acre. This variety has ripened well as shown by an average shrinkage of only 18.1 percent when stored in a dry place from husking time until spring. In the same test the Wooster strain of Clarage has yielded 69.0 bushels with a shrinkage of 18.9 percent. The yield is apt to be reduced by selecting either a variety that is too early to use the full growing season, or one that is too late to fully ripen before frost. For example, Minnesota 13 is a variety that ripens about a week before Medina Pride. It has given a 9-year average yield of 59.2 bushels at Wooster, with a shrinkage of 15.3 percent. On the other hand a southwestern Ohio strain of Reid Yellow Dent requiring about a week longer to ripen than Medina Pride has yielded only

61.2 bushels with a shrinkage of 29.3 percent. It is evident, that for best results, the variety or strain of corn grown must fit the growing season of the particular region. Strains which do best in northern Ohio are too early for southern Ohio, while the highest yielding sorts in southern Ohio are too late for northern Ohio.

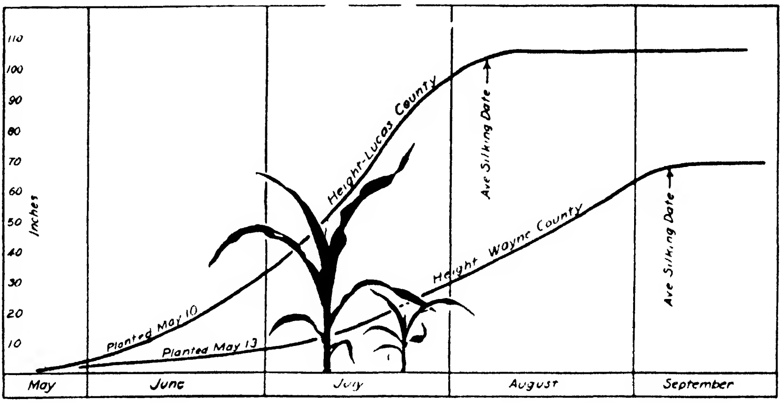


Fig. 1.—Curves showing increase in heights of Burr Leaming corn on good and poor soil in 1927

But, length of growing season is not the only factor to be considered. The time required for a given variety to mature is markedly influenced by the productivity of the soil. A variety which matures satisfactorily on rich land will often fail to mature when grown in a similar climatic region on poor soil. For example, in the season of 1927, the Experiment Station planted a single variety of corn, Burr Leaming, on nearly the same date at Wooster in Wayne County and at Bono in Lucas County. The soil at Wooster is a light colored acid silt loam of very low fertility, that at Bono is a nearly black limestone clay of high fertility. At Wooster it required 117 days to reach the average silking date; the corn at husking time carried 46.3 percent moisture; and the yield, reduced to a 15½ percent moisture basis, was only 17.6 bushels per acre. At Bono, only 90 days were required to reach the average silking date; the moisture content at husking time was 39.3 percent; and the yield, reduced to a 15½ percent moisture, basis was 75.2 bushels per acre. The rate at which the corn increased in height at the two locations is shown in Figure 1. By comparing the average silking dates, it is apparent that this variety was approximately 28 days earlier at Bono than at Wooster, a difference due in large part to the difference in productivity of the soils, since weather data showed little variation between the two places. It is clear, that on

productive land a later variety may be grown to advantage than on unproductive land, remembering that the latest variety that will mature properly is apt to give the highest yield.

In the tests just considered, no manure nor fertilizer was applied in either case, hence the differences observed were due to variations in the natural productivity of the soils. Differences in productivity brought about artificially by manure or fertilizer treatments may be just as important in influencing the maturity of the crop. This fact is well illustrated by the data given in Table 1 obtained with Burr Leaming corn in a corn fertilizer test at Wooster in 1927.

TABLE 1.—Results of Fertility Treatment on Burr Leaming Corn at Wooster in 1927

Treatment per Acre	Planted May 13				Planted June 3			
	Days planting to silking	Moisture at husking	Nubbins	Yield (15.5 percent moisture	Days planting to silking	Moisture at husking	Nubbins	Yield (15.5 percent moisture
	No.	*Pct.*	*Pct.*	*Bu.*	*No.*	*Pct.*	*Pct.*	*Bu.*
None	117	48.3	71	17.7	110	69.1	76	5.5
Manure, 8 tons; 225 lb. 16% superphos. broadcast	104	46.7	38	45.2	97	53.4	55	31.9
Same plus 100 lb. 3-12-4 in hill	99	37.9	37	55.9	93	50.7	42	33.3
Same plus 200 lb. 3-12-4 in hill	93	33.5	21	70.3	88	50.0	18	47.9
Same plus 400 lb. 3-12-4 in hill	90	31.4	12	80.6	86	46.0	19	56.9

The variety used in this experiment is ordinarily considered too late to be adapted to Wooster conditions. Yet, in spite of an unusually backward season, it ripened satisfactorily and gave excellent yields of grain when planted at the normal date, May 13, and treated with 8 tons of manure and 225 pounds of 16 percent superphosphate broadcast supplemented with either 200 or 400 pounds of a 3-12-4 fertilizer in the hill.

If we compare only the last or most liberal soil treatment with the plots receiving no treatment, and average the results from the two dates of planting, we find that the manure and fertilizer applied reduced the time from planting to silking by 25½ days. The moisture content at husking was reduced from an average of 58.7 to 38.7 percent, and the proportion of nubbins from 73.5 to 15.5 percent. At the same time, the yield, reduced to a uniform moisture basis of 15½ percent, was increased from an average of 11.6 bushels to 68.8 bushels. These differences are undoubtedly

larger than would be expected on a soil of higher natural fertility or in a more nearly normal cropping season. Nevertheless, it is clearly evident that the rate of development of the corn crop may be materially hastened by the right kind of soil treatment.

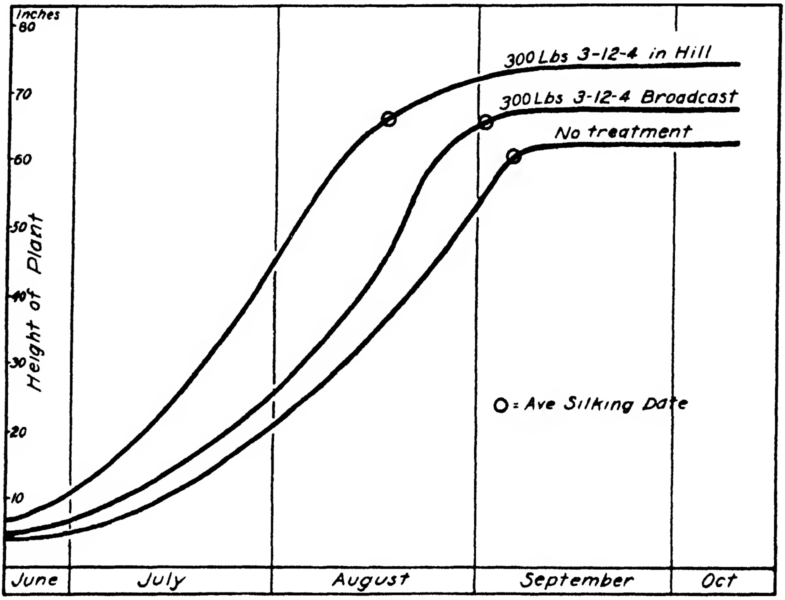


Fig. 2.—Curves for increase in height of Burr Leaming corn at Wooster in 1927. Hill application vs. broadcast application and no treatment

Under any given conditions of weather, drainage, soil reaction, etc., one would expect the corn plant to develop most rapidly when, at all times during its growth, there are present in the zone of soil encompassed by its roots sufficient nitrogen, phosphoric acid, and potash to fully meet its needs. If, during any interval, the supply of one or more of the nutrient elements is insufficient, then, growth will presumably be reduced and development retarded. Since the activity of soil micro-organisms has much to do in bringing soil nutrients into an available form, and since these organisms must await the arrival of favorable temperature and moisture conditions in the spring before they become active, it is in the months of May and June, especially in backward seasons, when nutrient deficiencies are most likely to prevail. For best results the soil treatment should provide for the needs of the crop during this early period as well as for its later growth. Experiments conducted by the Experiment Station show that broadcast applications of fertilizer or

manure, in the quantities normally applied, often fail to place sufficient plant nutrients within reach of the roots of the young plant to supply its full needs, even tho the treatment given, plus the nutrients made available in the soil, may be fully adequate later on.

It has often been observed that hill fertilized corn starts its growth at a more rapid rate than when the fertilizer is applied broadcast. It is easy to understand why this should be true. With corn planted in hills 3½ feet each way and the fertilizer applied broadcast, the application for a single hill of corn will be distributed over 1764 square inches of surface. If applied in the hill, thru the fertilizer attachment of a modern corn planter, the fertilizer will be distributed over an area of about 32 square inches. In other words, the fertilizer will be more than 50 times as concentrated in the area of soil into which the young plants first send their roots.

In a field experiment at Wooster in 1927 Burr Leaming corn was planted on May 13. One plot was given a broadcast application of 300 pounds of a 3-12-4 fertilizer. A second plot received 200 pounds and a third 400 pounds of the same analysis applied in the hill at planting time. By averaging the data from the two hill fertilized plots, the approximate effect of 300 pounds of 3-12-4 applied in the hill may be estimated and the results may then be compared directly with those from the broadcast treated plot. Curves showing how the crop increased in height during the season for the two methods of application and also for the plots receiving no fertilizer are shown in Figure 2. The average silking dates, moisture content at husking time, percent of nubbins, and yield of grain are shown in Table 2.

TABLE 2.--Results of Hill vs. Broadcast Application of Fertilizer on Corn at Wooster in 1927, Burr Leaming, planted May 13

Treatment per acre	Days planting to silking	Moisture at husking	Nubbins	Yield (15.5 percent moisture)
	No.	*Pct.*	*Pct.*	*Bu.*
None.................	117	48.3	71	17.7
300 lb. 3-12-4 broadcast	113	39.0	53	37.6
300 lb. 3-12-4 in hill*...	96	36.9	31	39.2

*Average of plots receiving 200 and 400 pounds of 3-12-4 in hill.

From the height curves in Figure 1 it is evident that in the early part of the season the hill fertilized corn grew much faster than that fertilized broadcast. On August 6 the average height of the plants on the no treatment plots was 27 inches. At the same time the corn fertilized broadcast was 32 inches high, while that

fertilized in the hill was 57 inches. From the data in Table 2 it is also seen that the hill fertilized corn silked 17 days earlier, carried 2.1 percent less moisture at husking, and contained 22 percent less nubbins. The superiority of 1.6 bushels in the total yield of grain for the hill fertilizer treatment tells only part of the story, since, after allowance is made for nubbins, there is a difference of 9.5 bushels of marketable corn in its favor.

Chemical analyses of the plants growing on these plots were made at intervals during the season. It is interesting to note that on July 11, the hill fertilized corn had already taken up 71.5 percent of the nitrogen applied in the fertilizer. At the same time the broadcast fertilized corn had consumed only 1.5 percent of the nitrogen applied.

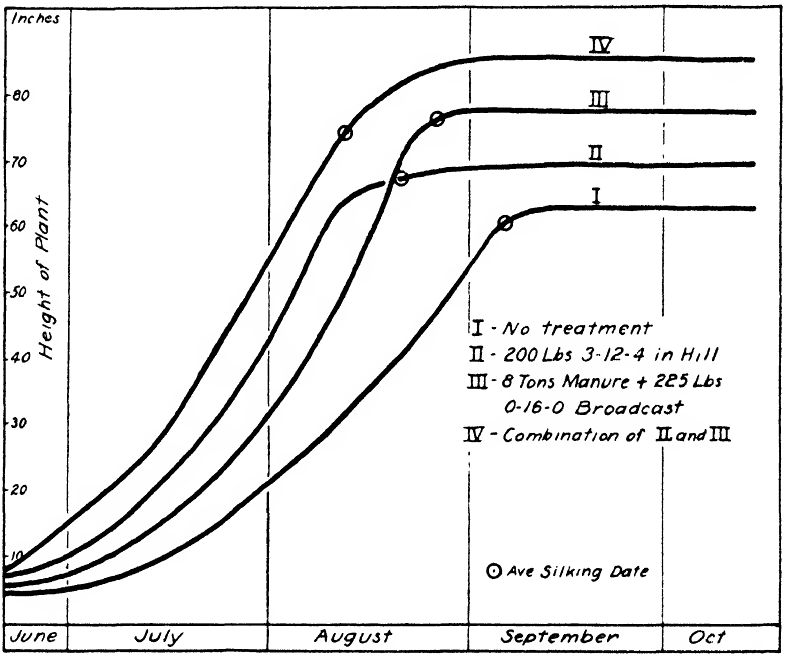


Fig. 3.—Curves for increase in height of Burr Leaming corn at Wooster in 1927, showing advantage of combining hill applications of fertilizer with broadcast applications of fertilizer and manure.

Applications of manure act in a manner similar to broadcast applications of fertilizer. The total amounts of nutrient elements supplied in a normal application of manure are however much higher than are carried by the usual application of fertilizer. Eight tons of well preserved mixed horse and cattle manure will

carry around 80 pounds of nitrogen, 40 pounds of phosphoric acid, and 70 pounds of potash. Two hundred pounds of a 3-12-4 fertilizer on the other hand carries only 6 pounds of nitrogen, 24 pounds of phosphoric acid, and 8 pounds of potash.

Manure, supplemented with a broadcast application of superphosphate, is a favorite treatment for corn in Ohio. That it is justly deserving of its popularity is shown by the results of a 28-year test at Wooster where 8 tons of shed manure supplemented with 320 pounds of 16 percent superphosphate has given an average increase of 35.6 bushels of corn. Stall manure alone used at the same rate has given an average increase of 25.0 bushels. In the experiments conducted at Wooster in 1927 a comparison was made between: (1) 8 tons of manure plus 225 pounds of 16 percent superphosphate broadcast, (2) 200 pounds 3-12-4 fertilizer in the hill, and (3) a combination of treatments (1) and (2). In Figure 3 the curves for increase in height of plant during the season are shown for these three treatments in comparison with the no-treatment plots. In spite of the fact that the manure and phosphate treatment carried six times as much total plant nutrients, the corn receiving only 200 pounds of 3-12-4 in the hill grew faster until about the middle of August. At this time the hill fertilized corn had apparently exhausted the supply of nutrients applied and the amounts which could be gleaned from the untreated and infertile soil between the hills were too small to meet the demands of the crop, so that the manured plot caught up and exceeded it in final height. The conclusion seems warranted that hill applications of fertilizer are best suited to supply the needs of the crop during the first part of the season but it is probably impractical on most soils to apply sufficient plant nutrients in this way to carry the crop thru to maturity. Manure and broadcast applications of fertilizer are apt to fail in supplying adequate nutrients to the young plant, but are well suited to supplying its needs during the later stages of growth. Presumably fertilizing constituents carried in green manure crops or those carried in the soil itself would class with manure and broadcast applications of fertilizer in this respect.

It is seen that the effects of manure and broadcast applications of fertilizer and those of hill applications of fertilizer are supplementary in character. A combination of the two methods of treatment might be expected to give better results than either alone. The curve for height of plants receiving the combination treatment included in Figure 3 shows this to be the case. The advantages of combining the hill fertilizer treatments with manure

For the broadcast fertilizer treatment, on either light or dark colored soils receiving manure, an application of 150 to 200 pounds of a 20 percent superphosphate, or its equivalent of another grade is suggested. Without manure or clover, a broadcast application of 150 to 200 pounds of an 0-14-4 or 0-14-6 analysis is recommended for all but soils of very low fertility where a 2-12-6 would probably be a better choice.

Double strength or concentrated fertilizers are especially adapted for hill or row applications since by their use the total quantity of fertilizer salts applied per acre may be reduced. Any possible damage to germination of the seed is thereby lessened. This makes the choice of such high analysis mixtures especially desirable where the corn planter is not of modern design.

CONTROL OF STOMACH WORMS IN SHEEP

D. S. BELL AND B. L. WARWICK

One of the problems of farm sheep raising is the prevention of injury and loss by stomach worms. Few farm flocks have not suffered from infestation. The losses have been such that stomach worms are frequently considered the greatest hindrance to successful and profitable sheep production in the farm states.

Sheep of any age are liable to infestation with stomach worms, but the heaviest infestations are usually among lambs. Infestation may occur at any season of the year. The trouble is usually first noticed in young lambs about the middle of the summer, tho it may become evident much earlier, depending upon the temperature and moisture conditions that have prevailed. Often the first notice that infestation is present is the death of one or more sheep or lambs. However, if the flock is closely attended the symptoms of stomach worms are usually noticed before death claims its victim.

The symptoms of stomach worm disease in sheep can often be recognized by the languid, lazy walk; drooping ears; hanging head; emaciated body; and shaggy wool coat. The picture in general is that of dullness, listlessness, and lack of thrift. Diarrhea is often present.

Close examination of an infested sheep reveals the skin pale and papery in appearance. The mucous membrane of the eyes and mouth is pale. The wool is dry and harsh, lacks luster, and is

usually tangled and shaggy. As the disease progresses respiration is increased and a painless, watery swelling sometimes appears under the jaw. The disease may run a rapid course or the infested animal may linger for weeks or even months before death. The duration of the disease usually depends upon the age of the individual and the severity of the infestation.

Fig. 1.—Infested ewe

A stary, ragged wool coat, and in some cases almost complete loss of wool, usually accompanies internal parasitic invasion.

To determine whether a flock is suffering from stomach worms the fourth stomach, which is the enlargement at the forward end of the small intestine, should be opened and examined. It should be opened by a full length incision on the upper side. Caution should be exercised so that none of the liquid escapes. If worms are present, they will be seen either adhering to the wall or folds of the stomach or swimming in the liquid contents.

Adult stomach worms vary in length from ½ to 1¼ inches and are about as thick as an ordinary pin. The female is larger than the male and is spirally striped red and white. This spiral striping of the female is a means of readily identifying the worm.

The life history of the stomach worm is divided into three stages: the egg; the larva; and the adult, or reproductive stage. Only in the larval stage is the stomach worm infestive if taken in by a sheep, and only in the adult stage is it parasitic within the sheep.

Stomach-worm eggs pass from the host with the feces. These eggs undergo only slight change until they reach the ground; but if the temperature is above 40° F. and the humidity is high, they develop into tiny embryonic worms. If the temperature and moisture conditions remain favorable, these newly hatched embryos feed, grow, and in a minimum of about three days reach the mature larval stage, at which time they are inclosed in a protective covering. The eggs and newly hatched larvae are very sensitive to adverse conditions of temperature and moisture and remain dormant or develop very slowly during dry weather or while the temperature is below 40° F. Either extreme dryness or freezing temperature is fatal to them. The mature larvae, on the other hand, are very resistant and withstand extreme dryness or severe cold for long periods of time. The mature larvae have been observed to live in water for five months, at freezing temperature for six months, and in soil and feces for eight months. They have been observed to live on pasture during the winter under climatic conditions which prevail as far north as Connecticut.

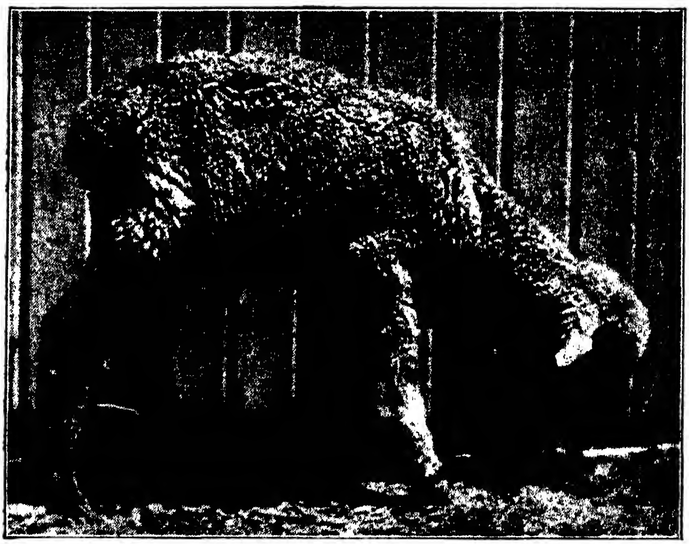


Fig. 2.—Infested lamb

When mature larvae are swallowed by a sheep they continue their development and in a minimum of about 18 days reach sexual maturity. Thus, 21 days is the minimum time required for these worms to develop from newly deposited eggs to mature worms, themselves capable of depositing eggs.

The modes and sources of infestation are many. When sufficient moisture is present and the rays of the sun are indirect and the temperature is above 40° F., the mature larvae migrate upward on blades of grass and are taken in by the sheep while grazing. The larvae are also capable of living in water and may be swallowed by sheep when drinking from small ponds or pools in contaminated premises. Sheep may pick up a few larvae from contaminated bedding, and nursing lambs may get some few larvae from the udder or wool locks of their dam.

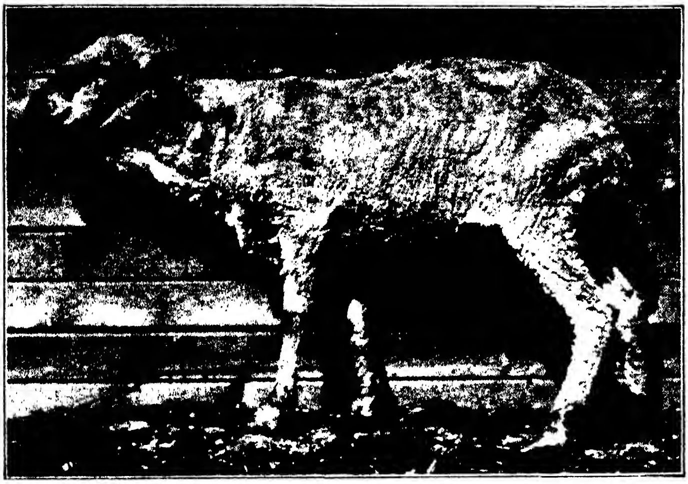


Fig. 3.—Ewe showing symptoms of Stomach Worms

Sheep or lambs that are free from stomach worms are almost sure to become infested when grazing with infested sheep, or when grazing upon land recently pastured by infested animals. It has been carefully estimated that one heavily infested sheep may pass as many as three million stomach worm eggs every twenty-four hours. Thus restricted pasture areas, such as small barn lots, lanes, or old permanent pastures, are likely to be polluted with infestive larvae.

The ewe flock is the source from which the worms are spread, and control measures should be directed toward all the sheep and lambs in the flock.

The methods of prevention that are effective are based upon the life history of the parasite. Uninfested sheep should not be allowed to graze along with those that are infested; nor on pasture that has recently carried infested animals. Lambs should not be held after weaning on permanent pasture that has carried the ewe

flock. Rather, the lambs should be provided uncontaminated pasture or forage. Such clean pastures are usually available in the form of newly-seeded meadows; meadows from which a crop of hay has been cut; inter-crop forages, as rape, soybeans, etc., that have been seeded with other crops; or forages seeded especially for the lambs. In addition to aiding in the control of stomach worms, this kind of grazing is more efficient in causing the lambs to gain and finish rapidly than are old permanent pastures.

It should be remembered, however, that, if the ewes and lambs have been grazed together prior to weaning the lambs, the lambs may have picked up some infestation during this period. A system can often be planned whereby the ewes only are turned out to graze during the day, and returned to the lambs at night. Under this system the lambs remain in the barn at all times until weaned at about four months of age. Experiments have shown that this system is highly effective in preventing stomach worm infestation.

Fig. 4.—"Bottle Jaw"

Edematous swellings appear on the lower jaw and lips in late stages of stomach worm disease. This ewe died several hours after the photograph was taken. Post-mortem examination revealed a very severe stomach-worm infestation.

Good feed allowed in liberal amounts aids the lambs to withstand stomach worms. The Oklahoma Station reports that, "Undoubtedly, the nature of the food is a great factor in the gradual removal of the worms from the host." A recent test at the Ohio Station showed that a high plane of nutrition, effected by allowing the lambs all the mixed grain they would eat, aided the lambs to withstand infestation and to put on gain at a rapid rate. However, 2 lambs out of the 15 in this group became quite heavily infested with stomach worms. This indicates that good nutrition is an important control measure when applied to the flock as a whole but cannot be relied upon in the case of every individual sheep or lamb. Further work is necessary before the exact relationship between the plane of nutrition and infestation can be stated definitely.

The same test at the Ohio Station showed that lambs which were treated at regular monthly intervals with copper-sulfate

solution and allowed all the grain they would eat harbored only 6.8 percent as many worms as similar lambs not fed grain and not treated with medicine. The regular monthly treatment alone, as indicated by still another group of lambs, was only 3.2 percent less effective against the worms than the combination of feed and treatment.

The feeding of tobacco, either in the feed or mixed with the salt, has proved ineffective against stomach worms at this and other stations. A salt mixture containing 1 cc. of 40-percent nicotine-sulfate for each ounce of salt was also fed to lambs on test. The lambs ate enough of the nicotine-salt mixture to cause the death of one lamb and the serious illness of another and yet the mixture was of no value in preventing stomach worm infestation. It would seem unwise to place too much reliance upon salt mixtures as worm preventives.

Treatment with copper-sulfate solution has been found highly effective against stomach worms. The Ohio Experiment Station has used and found effective a solution prepared by dissolving 2 ounces of uniformly blue crystals of copper-sulfate in 1 gallon of rain or distilled water.

This solution is administered according to the following dosage table:

For lambs 3 months old	$\frac{2}{3}$ fluid ounce, or 20 cc.
For lambs 6 months old	$1\frac{1}{3}$ fluid ounces, or 40 cc.
For yearling sheep	2 fluid ounces, or 60 cc.
For aged sheep	3 fluid ounces, or 90 cc.

In preparing the solution a glass, wooden, or earthenware vessel should be used, but never a metallic container. Both powdering and heating hasten the dissolving of the crystals. Care should be taken that the solution is kept thoroly mixed and that the dose is measured accurately.

It is usually considered best to withhold feed and water from the sheep for 12 hours before and 6 hours after treatment. Sheep should be kept in a standing position and handled so as to prevent struggling while being drenched. A satisfactory way to control a sheep is to back it into a corner, straddle its neck, and hold its head so that the nose is not higher than level with the eyes.

The medicine may be administered by means of a dosing syringe; a graduated drenching bottle; a measuring glass, hose with a metal mouthpiece, and a funnel; or a graduated siphon arrangement as devised by the Federal Bureau of Animal Industry.

Regardless of the equipment used, the dose should be accurately measured and should not be administered faster than it can be readily swallowed by the sheep. If the solution is administered too hastily a part of it may go to the lungs and produce mechanical pneumonia, but with careful dosing these cases are very rare.

It is safer to avoid dosing ewes during the last month of pregnancy. While no ill effects are likely to follow from the actual dosing, yet crowding or handling incident to the treatment may be injurious.

The Federal Bureau of Animal Industry has demonstrated that the treating of the entire flock with copper sulfate solution at four-week intervals is an effective means of preventing loss from stomach worms. This routine treatment has proved satisfactory at this Station. Ordinarily, early lambs receive their first treatment at weaning time, or when they are about four months of age.

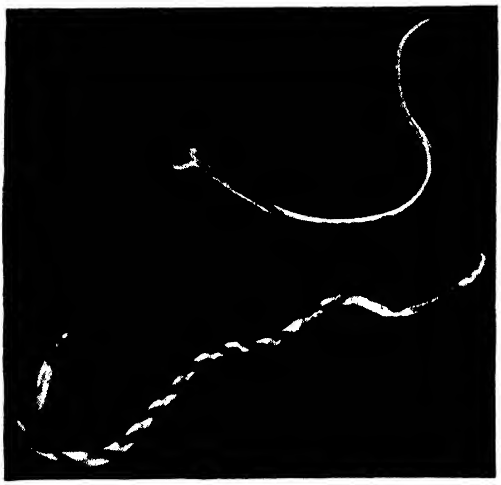


Fig. 5.—Adult stomach worms

Adult stomach worms, male (above) and female (below), enlarged about four times.

In severe infestation where it is imperative that the flock be rid of the stomach worms at the earliest possible date, the sheep should be given a second treatment 10 days after the first treatment was administered. This is often practiced in the case of feeder lambs. Sometimes three or even four treatments are called for. It has been noted that occasionally a very few individual sheep or lambs in a flock do not show improvement after the administration of a vermifuge. In studying the course followed by liquid drenches when given to lambs it was found that in a few instances the liquid all went into the paunch. It seems possible that the liquid drenches that go directly into the paunch become too dilute before reaching the fourth stomach to be of vermicidal value against the stomach worms present. In such instances where individual sheep have not responded to treatment they should be removed from the flock and re-dosed.

HIGH PROTEIN GRAINS AS A SUPPLEMENT TO PASTURE FOR DAIRY COWS

C. C. HAYDEN AND A. E. PERKINS

One of the first questions to be studied by our American experiment stations was that of feeding grain to dairy cows on pasture. Many of these early experiments failed to show much advantage from the practice, but the conclusion finally reached by most students of the subject was that on good pastures little would be gained by feeding grain to low producing cows. On the other hand, it was recognized that the heavy producers could not long continue to do their best and would soon decline in flesh even on the best of pasture, if no grain were supplied.

When the quality of the pasture in the experiments became poor from over stocking or dry weather, grain feeding became increasingly necessary to avoid heavy declines in milk yields and a condition of the animals which affected the milk production in later months as well.

Another subject which has been given much attention by experiment station workers is the best proportion of protein in the dairy ration. This question still remains in dispute, one group favoring grain mixtures made up chiefly of the home-grown and relatively low-priced grains, corn and oats, together with wheat bran supplemented by a small percentage of the more expensive, high-protein by-products. The other group insists on the use of much larger amounts of the high-protein grains, believing they are necessary for best results. Experimental work regarding the proportion of protein needed has been done almost entirely on winter rations.

It is known in a general way that growing pasture grass carries a considerably larger proportion of protein than the same plants have when full grown and made into hay. Therefore, it is assumed that less protein is needed in the summer than in the winter grain ration. Many, however, insist on the use of high-protein grain mixtures to supplement pasture. Information applying directly to this problem is almost wholly lacking.

In 1926, such cows in the Experiment Station herd as were available were fed grain mixtures of widely different protein

content on pasture during the months of June to September, inclusive, to obtain data on this problem. Three groups of six cows each were started on the experiment.

Group A was continued thruout the summer on the low protein grain mixture described below. The other groups were fed the high- and low-protein grains in alternate periods of 1 month each; Group B receiving the low-protein mixture in June and August, and the high-protein mixture in July and September; while Group C received the respective mixtures in the reverse order to Group B.

The two mixtures were supplied to the respective groups in approximately equal amounts, the production and apparent needs of the cow serving to adjust the individual allowance.

Beginning late in July, as the pasture declined in quality, silage was fed to all groups alike.

TABLE 1.—Total Individual Production of Cows in Groups B and C, June—September, 1926

Cow	Low-protein grain				Cow	High-protein grain			
	Month	Milk	Fat	Persistency coefficient milk		Month	Milk	Fat	Persistency coefficient milk
271	July	571.0	32.36	.809	271	June	705.4	38.66	....
271	Sept.	319.6	20.45	.746	271	Aug.	428.7	25.34	.751
265	July	393.3	18.63	.948	265	June	415.0	20.07	....
265	Sept.	341.7	17.13	.902	265	Aug.	378.7	17.80	.962
285	July	737.2	27.13	.912	285	June	808.3	30.30	....
285	Sept.	663.0	24.27	.986	285	Aug.	672.1	24.04	.911
121	June	1190.4	41.78	....	121	July	1093.7	36.21	.911
121	Aug.	959.1	28.74	.876	121	Sept.	897.3	28.26	.936
264	June	576.8	22.05	....	264	July	534.2	20.11	.926
264	Aug.	468.6	16.74	.877	264	Sept.	424.8	15.48	.906
292	June	805.6	27.09	....	292	July	743.1	22.39	.929
292	Aug.	600.9	19.47	.803	292	Sept.	544.6	18.18	.906
Total........		7627.2	295.84	....	....	....	7650.9	296.84	....
Average of groups B and C. ...				.873	....	....	....	....	.904
Total grain supplied..........2063 pounds					.....................................2121 pounds				
Total silage supplied..........5385 pounds					.....................................5465 pounds				
Total net live weight gains....186 pounds					.....................................46 pounds				

The pasture grazed by the cows in this experiment covered about forty acres of hilly land including several wooded ravines. The soil is classified as a silt loam. A great variety of grasses and weeds were to be found, but the pasture consisted mostly of a mixture of blue grass and white clover. It was allowed to attain a

good growth before pasturing started each spring. The cows were turned on this pasture about May 15, and at the beginning of the experiment, June 1, were already accustomed to pasture conditions.

The low-protein mixture used in our comparison consisted of corn 2 parts, oats 1 part, wheat bran 1 part, and carried about 12 percent total protein, or about 9.3 percent digestible protein. The high-protein mixture consisted of the same grains, with the addition of linseed oilmeal and 40 percent gluten meal as the carriers of the extra protein. The proportion was, corn 2 parts, oats, bran, linseed oilmeal, and corn gluten meal each 1 part, and carried about 20 percent total protein, or about 16.8 percent digestible protein.

TABLE 2.—Total Individual Production Group A Continuous Low-Protein Grain
June—September, 1926

Cow	Month	Milk	Fat	Persistence coefficient milk
119	June	955 8	50.81	....
	July	804.5	41.18	.841
	August	628.8	30.50	.782
	September	639.9	31.14	1.017
256	June	1357.9	50.29	....
	July	1179.0	40.88	.868
	August	1074.9	34.99	.903
	September	1012.3	33.68	.941
301	June	690.2	25.43	....
	July	658.3	27.75	.954
	August	608.2	23.27	.924
	September	649.8	25.04	1.068
293	June	813.4	29.27	....
	July	679.1	23.55	.835
	August	612.6	21.37	.902
	September	585.6	21.60	.958
286	June	665.5	30.09	....
	July	618.8	27.81	.930
	August	563.9	25.88	.911
	September	539.8	25.62	.957
Average	....	....	....	.919

Grain supplied, 3864.9 pounds
Silage supplied, 9420.0 pounds

Total net live weight loss, 133 pounds

Three cows remained in group B, three in C, and five in A. There was considerable individual fluctuation in live weight from month to month but the net resultant live weight was a slight increase over that at the beginning for groups B and C and a slight loss for A. The amounts of grain and silage consumed in addition to pasture, the live weight gains and the milk and fat production are presented in Tables 1 and 2.

It will be seen that the difference in production between the periods of high-protein feeding and those of low-protein feeding is practically negligible, being completely overshadowed by the natural decline in production which was present in all groups alike.

Probably the best modern method for making such comparisons is the so-called "coefficient of persistency of production" method. This coefficient is obtained by expressing each month's production as a percentage of the production during the preceding month. Averaging the coefficients thus obtained gives the average persistency coefficient for the year. This coefficient is more or less characteristic for each cow but is modified by various conditions such as the quantity and quality of the feed supplied.

When the production of the six cows in groups B and C during the low-protein periods is thus expressed as a percentage of a previous month's production on the high-protein grain the average persistency coefficient for the group was .873.

When the production during the high-protein feeding periods is likewise expressed as a percentage of the previous month's production on low-protein grain the average persistency coefficient for the group was .904. The persistency coefficient found for cows in groups B and C for the same months during former lactation periods using a grain mixture intermediate in protein content between those now under comparison was .894.

The cows in group A, receiving the low-protein grain mixture thruout the summer, showed an average persistency coefficient for the four months of the experiment of .919.

The small differences in results between groups B and C are well within the limits of experimental error.

The present work indicates that, under conditions similar to those existing in this experiment, the corn-oats-bran mixture would be considerably more economical to use than the grain mixture of higher protein content because of the higher cost of the latter and its failure to afford an increased production.

GOLD MEDAL COWS IN THE STATION DAIRY HERD

C. C. HAYDEN

During the year 1927 two Jersey cows in the Ohio Agricultural Experiment Station herd completed Register of Merit records, which entitle them to gold medals awarded by the American Jersey Cattle Club.

Fig. 1.—Wooster Lady, 477037

In January Wooster Lady 477037 completed a 305-day record (Class AAA) of 11,553 pounds of milk and 670 pounds of butterfat. Her monthly production is given in Table 1.

TABLE 1.—Monthly Production of Wooster Lady 477037

Month	Milk	Fat
	Lb.	*Lb.*
March	1,060	67.95
April	1,488	88.98
May	1,503	85.07
June	1,399	83.38
July	1,215	64.76
August	1,099	55.72
September	972	54.72
October	940	59.69
November	896	51.88
December	848	50.63
January	133	7.94
Total	11,553	670.72

This cow was milked 883 times during this record, twice a day for the first month and three times a day for the other 9 months. Her record was started when she was 6 years and 5 months old.

She had two other R. M. records. At 3 years of age she produced 7,324 pounds of milk and 456 pounds of butterfat; and at 4 years 5 months, 10,353 pounds of milk and 604 pounds of butterfat. She was milked but twice daily during these two records.

Two of her daughters, not yet in milk, are in the herd. One son is in service. Her dam produced 10,860 pounds of milk and 582 pounds of butterfat. Two 2-year-old maternal half-sisters have R. M. records, averaging 7,125 pounds milk and 446 pounds of butterfat.

Fig. 2.—Bessie's Bessie Nervilette, 440701

In November, Bessie's Bessie Nervilette 440701 completed a 365-day record (Class AA) of 14,903 pounds of milk and 754.68 pounds of butterfat and dropped a fine calf January 11, 1928. This record gave her a gold medal. She was 8 years and 1 month old when the record started; was milked three times a day; and stood in her regular stall with the rest of the cows. Her monthly production is shown in Table 2.

TABLE 2.—Monthly Production of Bessies' Bessie Nervilette 440701

Month	Milk	Fat
	Lb.	*Lb.*
November	1284	63.69
December	1570	81.64
January	1491	72.90
February	1243	60.90
March	1291	66.36
April	1255	63.88
May	1235	63.11
June	1170	56.39
July	1167	54.73
August	1140	54.72
September	1114	63.16
October	872	49.20
November	71	4.00
Total	14,903	754.68

Bessie has always been a good producer, never falling below 400 pounds of fat. The gold medal record, Table 2, was during her sixth lactation. All her records are shown in Table 3.

TABLE 3.—Yearly Production of Bessies' Bessie Nervilette 440701

Age	Milk	Fat	Class	Milkings daily
Yr. Mo.	*Lb.*	*Lb.*		*No.*
2— 4	7,668	441.11	A A	2
3 - 3	6,889	418.00	Private	2
4— 6	10,819	596.27	A	3 and 2
5 - 11	8,437	438.38	A A A	2
7 - 0	10,091	535.85	A A	2
8— 1	14,903	754.68	A A	3

At times this cow has been on experiments with rations not suited to high production. Her total production to February, 1928, was 59,455 pounds of milk and 3,204 pounds of butterfat. She is starting well on her seventh lactation but must go on a feeding experiment not conducive to high production. She has two good daughters with R. M. records, and two sons head other herds. She has four paternal half-sisters with records of 508, 516, 564, and 582 pounds of fat. Her dam was sold before completing her first lactation.

The four daughters of these two gold medal cows were sired by Choice Owl, whose first ten daughters to complete R. M. records at an average age of 2 years and 6 months averaged 7,280 pounds of milk and 410 pounds of butterfat.

RED CLOVER, STRAIN TESTS ON THE OUTLYING EXPERIMENT FARMS

J. S. CUTLER[1], W. E. WEAVER[2], AND J. D. SAYRE[3]

For several years Ohio has had short crops of red clover seed. Imported clover seed therefore must be used to satisfy the normal planting requirements. Tests of red clover seed from different sources indicate that the strains differ markedly in their adaptation to Ohio conditions.

In the eastern part of the United States, there are two important factors that cause clover failures. To the north, ability to resist winter killing is of prime importance; while in Tennessee, Maryland, and Virginia, disease is the major factor. Ohio lies in a transition zone between these two areas. As would be expected winter killing is the more important cause of failure in northern and northeastern Ohio; while disease is of importance in certain seasons in some southern Ohio counties.

Tests of red clover seed from different sources were completed in 1927 on the Clermont and Hamilton County Experiment Farms in cooperation with the U. S. Department of Agriculture. The strains were seeded in duplicate plots in the spring of 1926, with Fulghum oats as a companion crop. The plots received an application of superphosphate (acid phosphate). Ground limestone had been applied previously. Notes were taken on the stand in the fall after seeding, and on winter killing, yield of hay, and other characteristics the following year.

TABLE 1.—Red Clover Strain Tests in 1927, Yields of Hay per Acre

Strain	Hamilton County*	Clermont County†
	Lb.	*Lb.*
Ohio Certified	3080	3872
Michigan 2570	2680	3388
Wisconsin 2610	3080	3872
Tennessee 2574	2660	3600
French 2504	2300	3388
Chilean	2073	2541
Italian 2551	960	1331

*Field cured hay. †Air-dry, weed-free hay.

Yields.—The domestic-grown seed (Ohio, Michigan, and Wisconsin) produced the largest yields of hay in the two tests. This is in agreement with other tests in the State. Italian seed yielded only about one-third as much as these strains. The French seed

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gave satisfactory yields, altho not quite equal to those of the domestic strains. The Tennessee disease resistant strain yielded satisfactorily. The Chilean strain was inferior in yielding ability to both the French and Tennessee strains.

From the standpoint of yield alone the domestic and the French strains did about equally well. Other factors, however, must be considered.

Winter injury.—The ability of red clover to withstand winter injury is an important test of its value, as the lack of winter hardiness means decreased stands and usually lower yields. The northern-grown domestic seed proved superior in winter hardiness. Chilean and French were practically equal to native seed in winter hardiness. This is generally true except in years of a severe winter when the French strain winter-kills to some extent.

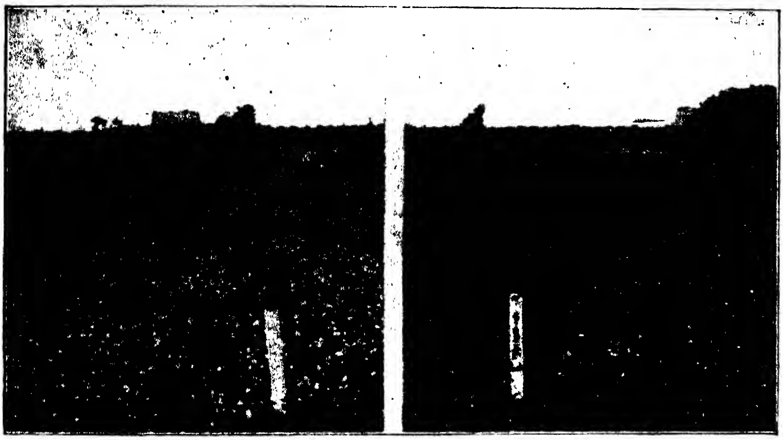


Fig. 1.—Recovery of clover after cutting.
Domestic, left; imported, right

The Italian strain here, as elsewhere, gave poor stands and low yields. Apparently southern Ohio is on the northern edge of the area in which the Tennessee disease-resistant clover is adapted, as only fair stands were secured. This strain winter-kills badly in northern Ohio. Seed produced in the mild climates of the Pacific Coast have not proved sufficiently hardy to withstand Ohio winters.

Generally speaking, clover seed from Michigan, Wisconsin, Minnesota, Canada, and the higher elevations of the Rocky Mountain States is adapted to Ohio conditions. The western seed differs markedly from seed produced in the Corn Belt in being larger, plumper, and more highly colored. It contains a greater proportion of the blue colored seeds. French, Chilean, and north European

seed can be used with quite satisfactory results. Pacific Coast seed and Tennessee seed are not quite hardy enough to survive Ohio winters, while Italian seed is practically worthless for planting in Ohio.

Recovery after cutting.—The foreign strains in these tests differed markedly in the rapidity with which they recovered after cutting. The domestic clovers produced sufficient second growth to make a fair cutting of hay. The Chilean and French produced little and the Italian no second growth.

Disease may be important.—The clovers from various sources showed little difference in susceptibility to disease in these tests. Tests in other states indicate that clovers from foreign grown seed, especially the Italian, are more susceptible to anthracnose than clover from native grown seed. The Tennessee disease-resistant strain in other states has been found to be more resistant to anthracnose than common red clover. Where disease is a factor good results are more often secured from locally grown seed than from seed grown farther north. Apparently seed produced in an area where disease is prevalent has developed more or less natural immunity. Farmers in southern Ohio, where anthracnose sometimes becomes quite serious, report better results from locally adapted seed than from hardy northern grown seed.

Staining indicates origin.—Imported seed can not readily be distinguished from domestic seed except by the staining. Under the present Federal seed laws all imported seed is stained to indicate its source and relative adaptation in this country. Italian and all foreign seed of unknown origin is stained red; Canadian seed is stained violet; and other foreign seed is stained green. A sufficient number of seeds are stained to make the detection of such seed fairly easy when examined. Just how effective the law will be is a question. Shipments of Italian, for example, seed have been traced to this country thru German ports.

The final analysis.—Domestic seed produced in the northern part of the United States, except the Pacific Coast states, and Canadian grown seed are likely to give the best results. Strains from these sources yield well and are sufficiently winter hardy to withstand Ohio winters. French, Chilean, and northern European seeds yield slightly less, are not quite as hardy, but differ chiefly in the slowness with which they recover after cutting, yielding only a small second crop. Tennessee and Pacific Coast seed are not sufficiently winter hardy for Ohio. Italian seed is absolutely unadapted. Where disease is a problem, local grown seed is to be preferred.

CULTURE AND VARIETIES OF SWEET PEPPERS

ROY MAGRUDER

The sweet or mild-fleshed garden pepper has increased greatly in popularity in the last ten years as a vegetable for use in salads and for general culinary purposes. Part of this popularity is due to the production of improved varieties, the better of which are very thick fleshed and free from any pungency.

Growing plants.—The pepper is a warm season crop. A temperature around 80° F. during the day and at least 65° F. at night will produce quicker germination and faster growth of the seedlings than lower temperatures.

The seed should be sown about 8 or 10 weeks before the plants are to be set into the field. Where the growing conditions can be carefully controlled as in a greenhouse, 8 weeks will be sufficient time for producing good plants, whereas a longer time will usually be required when they are grown in hotbeds or cold frames. Care and spacing should be the same as for tomatoes. At transplanting time the plants should be short, stocky, well hardened but in good growing condition with the first blossom about ready to open. Plants with hard and woody stems due to a check in their growth are not as productive as plants in an active growing condition.

Soil.—Peppers are more productive and earlier on the warm, sandy or sandy loam types of soil, altho they will grow well on almost any type provided it is well drained and is fairly fertile. A combination of very fertile soil and plenty of moisture often results in large vigorous plants with little or no fruit. It is better to select a light textured, well drained piece of soil with a southern exposure and supply the fertility in the form of well rotted manure and commercial fertilizer. An application of from 600 to 1000 pounds of a 2-12-6 commercial fertilizer per acre will be sufficient for most soils. On light, sandy soils or during cold, wet weather in the spring a top dressing of 150 pounds of nitrate of soda or sulfate of ammonia per acre may be given to stimulate the plants into an active growing condition.

Planting.—There is no advantage in setting out pepper plants while the ground is still cold as they will not grow until it warms up. They may become stunted in the meantime, and may even be killed by a late frost. Small growing varieties like Harris' Earliest, Sunnybrook, or Oshkosh may be set as close together in the row as

12 or 15 inches, but the larger growing kinds should be given 18 to 24 inches. Rows should be far enough apart to allow for horse cultivation, 30 to 36 inches.

Cultivation.—After the first or second time, cultivations should be shallow, as the pepper plant has a relatively shallow but widely spreading root system. Stirring the soil deeper than 1 to 1½ inches may do more damage than good by destroying the feeding roots in the upper layer of soil. Cultivations should be frequent enough to kill weeds.

Harvesting.—Most of the common varieties of peppers are either red or yellow when mature. The green peppers of commerce are really immature fruits. In order to secure the maximum yield of fruits that will hold up well on the market, the peppers should be as mature as possible. There is usually a limited demand for ripe, colored fruits for use in chili sauce and relish mixtures and early in the season prices for the colored peppers are usually higher than for green ones. The total yield per plant will be greater if the fruit is picked before it ripens; so a few rows should be set aside especially to produce ripe peppers.

Just before frost all the fruits may be harvested and if stored in a cool, fairly moist storage the more mature fruits will remain in good condition for four to six weeks. The most mature will ripen in storage.

Varieties.—In 1926 the catalogs of 44 representative seedsmen listed 66 different variety names of peppers. With such a large list from which to choose it is not surprising that the inexperienced gardener is in a quandary in deciding which variety to grow.

The following varieties have all been grown in the garden at the Experiment Station and are believed to be the best in the classes mentioned.

Earliest red.—*Harris' Earliest,* a small dwarf plant with small, fairly smooth, heart-shaped fruit, 2 inches wide by 2½ inches long. Flesh bright red, mild in flavor, but very thin. Identical with Baby Bell.

Earliest yellow.—*Prolific Yellow,* a medium size plant, with somewhat long, slightly tapering and irregularly shaped fruit, 2½ inches wide and 3½ inches long. Flesh clear yellow in color when ripe, mild flavored and thin. Very productive for so early a variety. An introduction of Livingston Seed Company.

Largest early red.—*Early Giant,* a medium size plant with medium to large, blocky, fairly smooth fruit, 4 to 5 cells, 3 to 3½ inches wide by 3 to 3½ inches long. Flesh very mild, of medium thickness and bright red color. A recent introduction combining

good size with earliness and red color. It promises to supplant the smaller early varieties. Sets 4 to 6 fruits very early and as these are removed continues to bear until frost (Fig. 1).

Fig. 1.—Early Giant pepper. Note heavy early set of large fruit. The cross lines in background are 1 foot apart

Earliest tomato-shaped pimento.—*Sunnybrook*, a small, flat topped, spreading plant with small, smooth tomato-shaped fruits borne erect in the center of the plant, 2½ inches wide by 1½ inches deep. Flesh very thick, dark red, and of pleasant mild flavor. This variety is much earlier and more productive than the Pimento and Sweet Salad varieties. It is equal to them in quality and may be used for the same purposes (Fig. 2).

Fig. 2.—Shows the upright, heavy bearing habit of these varieties. Sunnybrook plant is shown at left and Oshkosh at right

For stuffing.—*Oshkosh,* a small to medium size, flat topped plant with medium size, very smooth, broad heart-shaped fruit, 3 inches broad by 3½ inches deep, borne erect and often literally filling the center of the plant. When ripe the flesh is clear yellow, thick, and mild in flavor. Ripens in midseason and is very productive. The green fruits are of a dark, glossy green color making them very attractive. Being exceedingly smooth, heart-shaped, and of medium size they are particularly suitable for stuffing.

General purpose.—*Early Giant* is recommended where only a few plants of a single variety are desired, as it combines earliness and medium size, is fairly smooth, has mild flavored, red flesh of medium thickness, and will continue to produce until killed by frost.

FIELD DAYS AT THE EXPERIMENT STATION

Livestock Day, Friday, June 1
Wheat Field-Week, June 26-29
Poultry Days, June 28 and 29
Orchard and Garden Day, August 17

These annual events are planned so as to give farmers and others an opportunity to see the various experiments at a time near their close when the results can be studied to advantage and explained by members of the Station staff in charge.

It has been decided that the livestock now on winter feeding experiments will not be shown elsewhere in the State this year.

Special programs for these events are being arranged by the departments in charge. Each program will include inspection of the experiments under the leadership of members of the Station staff and speaking by men of nationally recognized authority.

Many delegations and individuals visit the Station on other days and are always welcome, but those who come on the special days will have the advantage of hearing the special discussions and distinguished speakers.

PRUNING THE RASPBERRY AND BLACKBERRY

J. S. SHOEMAKER

Raspberry and blackberry pruning is grouped into three headings: summer pinching, removal of old canes, and heading back canes and laterals while dormant.

SUMMER PINCHING

Pinching the young canes of certain types of brambles during the summer is done to check terminal growth, help the development of fairly low well branched stocky plants, and prevent the breakage of canes. The tips are pinched off with the fingers or cut off with a knife, shears, or other sharp instrument. At Wooster, the work is usually begun in the latter part of June and the plantation gone over several times. The red raspberry does not seem to respond beneficially to summer pinching.

New canes of the black raspberry are pinched when they attain a height of 18 to 24 inches, and blackberries and purple raspberries when they are 24 to 30 inches high. It is also a good plan to pinch back the laterals of blackberries when they are about a foot long. It is not advisable to cut back severely the canes of raspberries or blackberries after they have reached a height of three feet or more. Such practice tends to produce laterals from only the weakest buds on the cane.

REMOVAL OF OLD CANES

Raspberry and blackberry canes, for the most part, fruit only once and then die. Whether such canes should be removed soon after the fruit is picked or left in the plantation until the time of early spring pruning is a much mooted question. On the one hand, it is claimed that the old canes are of no further value in the plantation, that their removal permits the young canes to grow without obstruction, and that cutting out and burning them soon after the harvest is over, destroys insects and diseases present. On the other hand, some authorities are of the opinion that the old canes serve as a protection for the new canes against winter weather, that the amount of disease, particularly anthracnose, controlled by destruction of the old canes after harvest is overestimated, and that the dead canes do not appreciably obstruct the growth of new canes The practice followed at Wooster, and the

one recommended for raspberries at the present time, is to cut out and burn the old canes soon after the close of the harvesting season; and for blackberries at the time of spring pruning.

HEADING BACK CANES AND LATERALS

The regular dormant pruning of raspberries and blackberries is best done in early spring. It is usually delayed until the amount of winter injury can be ascertained, but should be done before growth starts or the soil becomes soft and muddy. The various types of raspberries and blackberries are not pruned alike for best results. The proper amount of pruning varies not only with the type and with the variety but also according to the vigor and other growth conditions.

For the most part judicious application of fertilizers, particularly nitrogenous fertilizers, increases the vigor and subsequently the yield. Application of 200 to 300 pounds per acre of sulfate of ammonia or nitrate of soda about two weeks before bloom has enabled the plants to support more fruiting wood than weaker ones, and at the same time to withstand summer drought conditions better.

Black raspberries.—Cumberland is the most widely grown black raspberry in the State. Most attention, therefore, is given to the pruning of this variety.

Dormant pruning experiments with the Cumberland black raspberry were conducted at the Ohio Experiment Station in 1927. Diameter measurements, 6 inches above the surface of the ground, were first obtained for each cane under study. Canes were treated by cutting back the laterals to 8, 12, 18, and 24 buds. Other canes were left unpruned. At least 10 canes were used for each treatment or measurement.

TABLE 1.—Cumberland: Diameter of Cane in Relation to Yield and Growth

Diameter in inches	Average number berries			Average shoot growth, inches		
	Main cane	Laterals	Total	Main cane	Laterals	Total
3/16— 4/16	53	82	135	71	127	198
5/16— 6/16	129	178	297	141	185	326
7/16— 8/16	51	325	376	65	346	411
9/16—10/16	109	363	472	120	424	544

Canes grouped into four classes based on diameter measurements, as shown in Table 1, indicate that the thicker the canes the greater the fruit production and shoot growth. Since there is a

Fig. 1.—Raspberry pruning and types of growth

Cumberland raspberry (upper left hand): laterals are cut back to 8 to 12 inches. Laterals of strong healthy canes should be pruned longer than those of less robust canes.

Early Harvest (upper right), showing position of fruiting shoots relatively close to main cane. Compare with Blowers.

Blowers (lower right): fruiting shoots, for the most part, are located relatively distant from the main cane.

Pinching off the tips of black raspberry canes when they reach a height of 18 to 24 inches (lower left) is recommended.

direct relation between vigor and productivity, it is advised that practices leading to the development of canes of large diameter be followed.

Table 2 shows that the more severe the pruning the greater the percentage of fruit-bearing shoots on the main cane and laterals. The average length of these fruiting shoots increased with the greater amount of pruning. Unpruned canes made about the same total shoot growth as the pruned ones, but the shoots on the unpruned canes were more numerous, shorter, and less fruitful, and the fruit was inferior in size, quality, and appearance. Shoots of one or two inches seldom bore fruit.

TABLE 2.—Cumberland: Amount of Pruning in Relation to the Percentages of Shoots Fruiting, Length of Fruiting Shoots, and Number Berries Produced per Cane

Treatment of laterals	Percentage shoots fruiting		Average length fruiting shoots in inches		Average number berries per cane
	Main cane	Laterals	Main cane	Laterals	
Pruned to 8 buds	75	64	16.4	11	257
Pruned to 12 buds	73	61	15.3	10	264
Pruned to 18 buds	71	57	14.2	9	271
Pruned to 24 buds	65	55	12.9	8	273
Full length	62	48	12.1	7	306

The last column in Table 2 indicates that the more severe the pruning the smaller the number of berries produced. Observations at Wooster tend to show that laterals pruned to 8 buds bore fruit of higher quality, larger size, and better appearance than those pruned more lightly, or not pruned. There seemed to be little difference between the grade of fruit on 8- and 12-bud lengths, altho possibly that on the 8-bud lengths was slightly superior. Fruit borne on 18-bud lengths or longer was often muddy, and usually inferior in size and quality. In general, pruning tended to decrease the yield and increase the quality and size of berries.

Pruning the laterals to 8 to 12 inches is suggested for most bearing plantations of the Cumberland in Ohio. Plantations where growth is not as vigorous as could be desired should be pruned somewhat more severely than those where the canes remain strong and healthy.

Weak, slender canes may just as well be removed, but thinning large, strong, healthy canes to fewer than 4 or 5 in the hill is not advised. The more strong canes per hill and per acre the higher the yield is likely to be, altho the number of canes per hill can be excessive.

Red raspberries.—Dormant pruning studies were made in 1927 at Wooster with the King red raspberry. Diameter measurements, 6 inches from the ground, were taken before pruning the canes. More than 50 canes were cut back one-fourth and about the same number were left unpruned. Original and pruned heights were noted. The plants were grown under the hedgerow system.

Data in Table 3 show that there was a direct relation between diameter of cane and fruit production and shoot growth. There is some indication that naturally branched canes bear more fruit than single canes, and that the unpruned canes produce more berries than those cut back one-fourth.

TABLE 3.—King: Diameter of Cane in Relation to Yield and Growth

Diameter class in inches	Average number berries				Average shoot growth, inches			
	Single canes		Branched canes		Single canes		Branched canes	
	Cut back ¼	Not pruned	Cut back ¼	Not pruned	Cut back ¼	Not pruned	Cut back ¼	Not pruned
3/16—4/16	30	51	30	54	70	81	87	96
5/16—6/16	67	127	64	72	127	107	140	100
7/16—8/16	108	137	160	171	170	159	235	243

Table 4 indicates that the taller the canes the greater the production of berries, number of shoots, and inches of shoot growth. The height of the pruned canes refers to the amount left after cutting back.

TABLE 4.—King: Height of Unbranched Cane in Relation to Yield and Growth

Height in inches	Canes cut back one-fourth			Canes not pruned		
	Average number berries	Average number shoots	Average inches shoot growth	Average number berries	Average number shoots	Average inches shoot growth
15—19..........	14	10	21	10	8	36
20—24..........	20	12	39	33	12	80
25—29..........	83	19	119	34	13	87
30—34..........	101	21	156	67	14	124
35—40..........	133	23	165	85	18	149
41—44..........	148	25	192	106	21	164
45—48..........	152	30	195	129	24	179
49—52..........	167	31	208	133	28	193

The unpruned single canes produced a higher average number of berries and more shoot growth than the canes cut back one-fourth (Table 5). The same was true for the branched canes.

There did not seem to be much appreciable difference in the size of fruit from the pruned and unpruned canes, altho in dry seasons heading back might result in larger sized berries.

The best method of pruning the King red raspberry seems to be to head back the canes and branches as lightly as is compatible with suitable training, freedom from damage in cultivation, ease of harvesting, and other operations. A light to moderate heading back is also recommended for other red raspberry varieties.

Small, slender canes may well be removed. Some thinning out of canes in the hedgerow is usually necessary but removal of too many canes will reduce the yield. Higher yields per acre are likely to be obtained from the hedgerow than from the hill system but for growers who use the latter method it is suggested that 7 to 9 of the most vigorous canes be left per hill. The hedgerow should be kept relatively narrow.

TABLE 5.—King: Cutting Back of Canes in Relation to Yield and Growth

Treatment	Average number berries		Average shoot growth, inches	
	Single canes	Branched canes	Single canes	Branches canes
Cut back ¼	67	72	123	101
Not pruned..........	83	115	134	155

Purple raspberries.—For Columbian and Haymaker, the two principal purple raspberries in Ohio, a pruning length of about 10 to 14 inches for laterals is generally recommended. The length to which the laterals of purple raspberries should be shortened, however, depends considerably on the vigor of the canes. Vigorous healthy canes can stand more wood than weak ones.

Blackberries.—Blackberry varieties seem to vary more greatly than black raspberries in fruiting habits. As a rule, laterals of Early Harvest can be shortened more than those of Eldorado, and in turn laterals of Eldorado more than those of Blowers. If the laterals are pinched back to a foot in early summer the secondary laterals will not be as long as if this operation is omitted; and the fruit will be closer to the main cane. For laterals of Eldorado a length of about 1½ feet and of Blowers around 2 feet or slightly more is generally recommended. Pruning should be regulated somewhat in accordance with the vigor; the more vigorous the canes the longer the laterals can be left to advantage. Shortening the laterals of blackberries does not seem to force the buds into fruit as it does those of black raspberries.

THE RELATION OF HUMIDITY AND VENTILATION TO THE LEAF MOLD DISEASE OF TOMATOES

A. G. NEWHALL

Leaf mold of tomatoes, *Cladosporium fulvum*, has caused severe losses in Ohio greenhouses. The practice of growing fall tomatoes in place of lettuce has aggravated the situation by shortening the interval between tomato crops. A reduction in yield amounting to nearly half the crop is not unknown. A single greenhouse sometimes loses several thousand dollars on one crop.

Repeated experiments with both copper and sulfur fungicides have given very unsatisfactory control both in the liquid and dust form. Not only is it difficult to wet the surface of the plant and the spores but in repeated tests on glass slides in moist chambers the spores have shown great tolerance for both sulfur and copper. Other workers have reported similar findings.

All students of this disease are agreed that it may be controlled if the plants are given adequate ventilation. The trouble with most greenhouses is that it is practically impossible to provide adequate ventilation at critical periods in the late spring and early fall when it is most needed, that is, when the weather is hot, damp and muggy. From an engineering standpoint it is possible to provide extra ventilation during critical periods, if this can be shown to be a successful method of controlling the disease.

TABLE 1.—Spore Germination of *Cladosporium fulvum* at Different Humidities (Sulfuric acid humidity chambers), Room Temperature

Strength H_2SO_4	Calculated rel. hum.	Spore germination	
		After 41 hours	After 88 hours
	Percent	*Percent*	*Percent*
None	100	86	87
5.0%	98.5	89	91
6.66	97.7	29	51
7.50	97.3	9	21
8.33	96.9	0	14 very weak
10.00	96.1	0	0

The results of recent studies of the relation of humidity to fungus activity and of air circulation to humidity and evaporating power of the air indicate that some form of forced air ventilation would be effective in preventing leaf mold development.

It is now known that the fungus can develop normally and rapidly on plants that are not sprinkled. A crop that is carefully "bottom" watered is as subject to attack as one sprinkled overhead. It is not necessary for the spores to be in a film of water in order to germinate. However, they will not germinate in an atmosphere having a relative humidity below 96 percent at ordinary temperatures. Best germination occurs between 98 and 99 percent relative humidity.

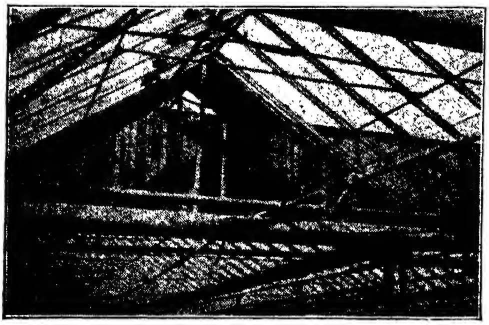


Fig. 1.—Showing the main air duct over the walk, and one vent open (←) directing the air out into the house.

Even tho the spores require a humidity above 96 percent to germinate, it has been found that on plants in chambers where the air is not in motion, the disease will progress normally when the air appears to be as low as 80 percent R. H. This indicates that in quiet air of such humidities the leaves may be giving off enough moisture at their surfaces to build up the humidity in the immediate vicinity of the spores to a favorable point for germination. This is supported by our knowledge of the amount of water given off by the tomato plant.

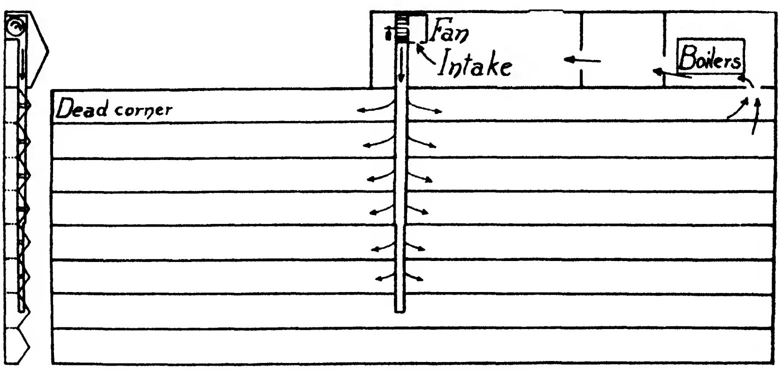


Fig. 2.—Plan of Darrow greenhouse forced ventilation

Records of the water loss from tomato plants 16 inches high show that an acre of such plants can easily give off over 40 gallons of water per hour during the heat of the day. Older plants 5½ feet high may give off 100 to 200 gallons per hour. In a commercial greenhouse this must be absorbed by the air or it will condense as

dew on the plants. Physicists tell us that an acre of air 10 feet thick at 77° F. can hold only about 80 gallons of water. The problem of ventilating to get rid of the excess above this amount becomes, therefore, increasingly important as the plants increase in size.

TABLE 2.—Effect of Air Movement on Evaporation

	Evaporimeter readings	Temperature	Rel. humidity (psychrometer)
Expt. 1, ventilators:			
Closed	1.06 cc. per hr.	60°F	40%
Opened 1½ inches	2.17 cc. per hr.	50	42
Closed	.95 cc. per hr.	60	35
Expt. 2, fan:			
Turned off	.85	60	60
Turned on	1.43	....	....

Fortunately, as soon as air is stirred, its evaporating power is greatly increased. Even such low velocities as ½ mile per hour (44 feet per minute) may often double the evaporating power of the air with respect to a moist object like a leaf or a porous clay atmometer bulb. The effect of "cracking" the ventilators even as little as an inch or two when the wind is blowing outside is very marked. Evaporation may thus be doubled even tho no appreciable draft is started. Similarly, a small electric fan in a closed chamber has the same effect even tho no draft can be felt.

TABLE 3.—Evaporation Readings in Darrow Brothers Greenhouse

	Fan	Distance from duct openings	Water loss per hour	
			Plants growing	Plants out
1	Turned on	160 ft.	0.22 cc.	0.54 cc.
2	Turned on	85 ft.	.42 cc.	1.8 cc.
3	Turned on	15 ft.	.88 cc.	3.6 cc.

These principles are applied in the commercial greenhouse of Darrow Brothers, at Poland, Ohio. A system of forced air circulation drives air into a central duct across the middle of the greenhouse by means of a steam-engine-driven, 10-foot blower, obtained from an old school building. Enough air is continually added from outdoors to keep the evaporating power always in advance of the needs of the plants so that no dew ever forms during critical periods. Tests have shown that in their greenhouse the air has approximately twice the evaporating power when the fan is in operation. A Wilson type of Livingston white bulb, quick-reading atmometer (evaporimeter) was used in making these tests.

Leaf mold was present in one corner of their house on the last tomato crop but made no progress during the four months when the fan was in use. The fan has a calculated capacity of 20,000 cubic feet per minute. In their greenhouse of 1½ acres the air was changed theoretically in 22 to 32 minutes, depending on the speed of the fan and size of the plants impeding the circulation.

On the strength of this apparent success several other greenhouses in Ohio are being equipped with some type of forced air ventilation. At the Experiment Station experiments are under way to determine how often the air must be changed at different humidities to prevent leaf mold development.

CELERY DUSTING IN 1927

J. D. WILSON

The use of sprays and dusts in controlling the blights of celery has been studied at this station for several seasons. Last year a number of different dust mixtures, including several commercial brands and freshly-mixed formulas, were tested out in twelve different localities in the northern half of Ohio. The season of 1927 was not one of heavy or even average blight infection, due largely to the combination of temperature and rainfall conditions which were unfavorable to the blight organisms at normal infection periods. Three of the twelve fields showed almost no blight of either the early or late forms and in three others the infection was so light as to make the counting of blight spots or the taking of yield data inadvisable. On the remaining fields, however, the blight was sufficiently severe on the check plots to reduce the yields materially below those of the plots that had been treated. Of these six experimental fields five were infected with late blight, caused by *Septoria apii*, and the other by early blight or *Cercospora apii*. Bacterial blight was not noted in any field in 1927. All of the results given here were on late celery except one field, which was harvested about September 20. A hand duster was used in applying the dusts because of the small size of the plots.

The following table gives a summary of the results from four of the fields in which the data seemed the most reliable. The treatments used are listed in the first column on the left. They are arranged in the order of the control which they gave, as shown in

the third column. The second column indicates the number of trials given a treatment. The third column shows the percentage of control. This percentage was obtained by considering the number of blighted leaves per 100 feet of check row as 100 percent infection, then subtracting the number on a treated plot for the same area from this check number and dividing the check number into the difference. In the last column is given the percentage of increase in yield due to treatment over that of the check. The yield numbers are not as reliable as the control numbers due to the small number of plot replications, which did not sufficiently eliminate soil influences.

TABLE 1.—Summary of Celery Blight Control, 1927

Treatment	Number of tests	Percent control (blight on check equals 100)	Percent increase in yield over check
20-40-20 copper-lime-kaolin-infusorial earth	1	95.0	44.5
20-80 copper-lime	4	91.0	45.6
20-40-40 copper-lime-kaolin	1	91.0	41.0
20-60 20 copper-lime-kaolin	3	89.3	42.1
S-11 (N. Y. Insecticide Co.)	5	89.0	39.2
710 (General Chemical Co.)	2	88.5	43.7
D-6 (Niagara Sprayer Co.)	5	88.2	36.6
40-60 copper-lime	1	87.6	32.0
20-60-20 copper-lime-infusorial earth	2	84.0	41.4
9 percent copper-lime-clay-arsenate	1	84.0	27.8
Grower's control-commercial dusts (average)	3	67.3	30.7
Average all freshly-mixed dusts	13	89.0	41.3
Average all commercial dusts	12	88.6	38.9

A number of freshly-mixed dusts were used in an effort to determine whether any mixture, in which part of the lime of the standard 20-80 monohydrated copper-sulfate-hydrated lime dust was replaced by other compounds, or in which the amount of copper was varied, would be an improvement over the 20-80 mixture in any way. For instance the mixture shown in the first line of the table was made up of 20 parts of monohydrated copper-sulfate, 40 parts of hydrated lime, 20 parts of kaolin, and 20 parts of infusorial earth. This and some of the other mixtures seemed to flow thru the duster and stick to the leaves very well but they were not any more efficient in blight control than the standard 20-80 copper-lime formula.

The averages given in the last three lines of the table are of particular interest and sum up two or three of the points which were being investigated in the dusting program on celery in 1927. First, it is shown that the freshly-mixed dusts which included a wide range of proportions and a number of different materials, were just a little more effective, as indicated in an average, in controlling

blight than were the standard commercial brands. The percent of control was slightly better and the yield noticeably so. Also it is evident that the average commercial celery grower is not getting the maximum possible return from his dusting program, due probably to lack of care in the time and manner of application of his materials. The experimental plots were dusted only at times when the leaves were wet with dew, usually in early morning, and at fairly regular intervals thruout the growing season from shortly after planting to just before bleaching.

Thus it seems likely that any reliable commercial or freshly-mixed copper-lime dust will give satisfactory control if proper care is used to obtain an even distribution and if the applications are made at proper time intervals and only when the leaves are moist.

WHY LET LICE AND MITES TAKE POULTRY PROFIT?

WEEKLY PRESS BULLETIN

Now is the time to fight lice and mites. Whether he lose or win is now up to every poultry keeper. I ice and mites like weeds in a corn field are signs of neglect. The tremendous loss to poultry keepers caused by lice and mites each year is needless. We seek new remedies and solutions for this and that, but too often we fail to utilize the valuable things already at our command.

We have an effective way of eradicating lice by means of sodium fluoride, says D. C. Kennard, in charge of poultry investigations at the Ohio Experiment Station. It is easy to apply and inexpensive, and yet how many fail to take advantage of this valuable procedure. Some persons resort to fanciful procedures which are much more costly and less effective and safe than fluoride.

Caution should be exercised in the use of a lice or mite eliminator that gives off a vaporizing material having a strong odor intended to repel or kill lice or mites. In some instances there has been loss from eggs becoming tainted and the flesh of the birds may also likewise become affected. It should be remembered that the yolk of egg is very susceptible to such odors.

For destroying roost mites no fancy or costly material is necessary. Simply spray roosting quarters and paint roosts with refuse oil from an automobile or gas engine. For further particulars write your Agricultural College or Experiment Station.

HORSES ON OHIO FARMS

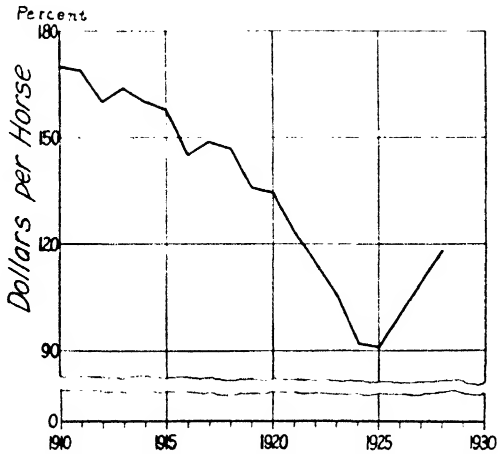
J. I. FALCONER

The January 1, 1928, figures as released indicated that the number of horses on Ohio farms continues to decrease. This is a trend which has been in progress since about 1910.

No. of Horses on Ohio Farms

1910	910,224
1920	810,692
1925	650,012
1926	598,000
1927	568,000
1928	542,000

What is true in Ohio is true in other states. There are indications, however, that this decline in numbers has begun to be reflected in the prices paid for horses. From 1910 to 1924 or 1925 there was a steady decline in the price of farm horses; since 1925, however, prices have been improving.



Horses: value per head on Ohio farms

Such data as are available relating to the number of colts in the country would also indicate that the present number of colts born will come far from maintaining the present number of horses on the farm.

Colts Foaled Per 1,000 Horses and Mules on Farms and Ranges

	Colts born during								
	1919	1920	1921	1922	1923	1924	1925	1926	1927
East North Central States ...	74.	16	60	45	36	32	35	27	32
United States.................	91	83	71	60	49	47	42	41	42

SHIPMENTS OF OHIO POTATOES

CHAS. W. HAUCK

Of the total carlot movement of white potatoes in the United States, only a small part originates in Ohio. The greater part of Ohio potatoes is consumed locally. During the nine years 1919 to 1927, inclusive, shipments from Ohio points averaged only 193 carlots annually, or about 1 percent of the average yearly production of the State. When compared with those states which lead in the production of late-crop potatoes this seems small indeed. During these same years Maine averaged 32,482 carlots annually, New York 15,768, Michigan 15,683, and Minnesota 27,258. Many other states exceeded Ohio.

Prior to 1925 Ohio's annual shipments fluctuated from 41 cars to 144. In 1925 there was a sudden increase to 479 cars, probably due to the combined influence of a short crop in the country at large, with resulting high prices, and a relatively large crop in this State. This increase has not been sustained, altho shipments in 1926 and 1927 did not recede to the level of the years prior to 1925.

TABLE 1.—Carlot Shipments of White Potatoes From Ohio Points, 1919-1927, by Months

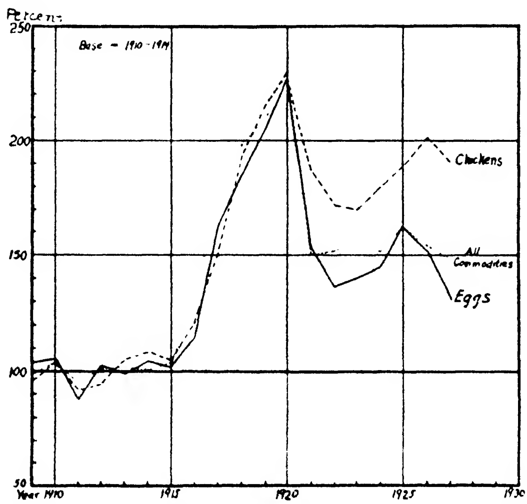
Year	1919	1920	1921	1922	1923	1924	1925	1926	1927	9-yr. av.	Percent
January	9	4	4	1	6	4	....	25	13	7	3.7
February	9	3	....	1	3	4	1	31	18	8	4.1
March	4	6	5	1	9	4	1	11	25	7	3.7
April	24	9	2	3	10	11	....	5	16	9	4.7
May	7	....	7	1	1	6	1	1	4	3	1.5
June	1	....	1	....	....	5	....	....	....	1	.5
July	....	5	....	....	5	....	12	....	3	3	1.5
August	2	....	1	1	23	15	42	56	26	18	9.4
September	5	33	....	13	22	10	98	28	145	39	20.2
October	23	47	12	21	24	2	242	34	84	54	27.9
November	34	35	6	26	56	34	69	67	33	40	20.7
December	4	2	3	5	3	2	13	4	3	4	2.1
Total	122	144	41	73	162	97	479	262	370	193	100

During the last nine years an average of approximately 69 percent of Ohio's shipments were during September, October, and November. Manifestly only a small proportion of the potatoes grown in this State were held in storage for late shipment; most of the crop was shipped at or soon after harvesting. Shipments from Maine during these months averaged 33 percent, from New York 41 percent, from Michigan 35 percent, and from Minnesota 47 percent. Shipments from these states in January, February, March, and April comprised from one-third to almost one-half of their yearly movement, while Ohio shipped only 16 percent during these months.

POULTRY AND EGG PRICES

J. I. FALCONER

By the accompanying chart it will be seen that since 1921 egg prices for each year have averaged less than the general level of prices. The year 1927 experienced the lowest egg prices of any year since 1916. The fact, however, that an increasing proportion of the eggs are being produced during the months of high prices and that production methods are being improved may make the position of the egg producer actually better than this level of prices for the years would indicate.



Index of poultry and egg prices since 1910

Chickens on the other hand have maintained a favorable price position since 1921, altho not quite as high in 1927 as in the previous year. In fact chicken prices have thus far since 1920 maintained the highest price level of any of our major farm products. During the years 1921 to 1927, inclusive, the index of all commodity prices (using the years 1910-1914 as 100) has averaged 153, that of the farm price of Ohio eggs 145, and that of the farm price of Ohio chickens 183.

INDEX NUMBER OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

In January and February of 1928 the prices of Ohio farm products reached the lowest point since September of 1924; they were four points lower than in January and February of 1927. This fall in the price level was largely due to hogs which were bringing $11 in October and but $8 in February.

It is also interesting to note that, while in the year 1927 the price level for Ohio farm products ruled considerable above the level of farm product prices for the United States as a whole, they had nearly reached a common level by the first part of 1928. For the United States farm products prices averaged 131 in 1927 and 137 in February of 1928, a rise of 6 points. For Ohio on the other hand farm prices averaged 147 in 1927 and by February of 1928 had fallen to 141, a decrease of 6 points.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Non-agricultural products U. S.	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Farm products prices Ohio
1913	102	...	105	100	104	100	104
1914	100	100	97	102	102	102	105
1915	103	101	101	100	103	107	106
1916	130	114	138	117	113	113	121
1917	181	129	182	176	140	119	182
1918	198	160	188	200	175	131	203
1919	210	185	299	209	204	135	218
1920	230	122	141	205	236	159	212
1921	150	203	167	116	164	134	132
1922	152	197	168	124	145	124	127
1923	156	214	171	135	166	122	134
1924	152	218	162	134	165	118	133
1925	161	223	165	146	165	110	159
1926	154	229	161	136	170	105	155
1927	149	231	152	131	173	99	147
1927							
January	150	232	156	116	172	...	145
February	179	231	155	127	...	...	145
March	178	234	153	126	...	99	144
April	177	230	151	125	172	...	144
May	177	230	150	126	...	...	145
June	176	230	150	130	...	...	147
July	177	228	151	130	174	...	147
August	179	231	151	132	...	...	149
September	152	233	152	140	...	...	149
October	152	231	151	139	175	...	150
November	152	226	151	137	...	...	149
December	152	233	151	137	...	...	145
1928							
January	151	230	151	137	158	...	141
February	151	...	152	137	...	...	141
March	...	...	...	...	...	98	...

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Ohio Agricultural Experiment Station

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OHIO AGRICULTURAL EXPERIMENT STATION

Wooster, Ohio, U. S. A.

Chrysanthemums and Pompons

Left: Healthy chrysanthemums on sterilized old soil in raised benches
Right: Longer stems of pompons at extreme right on new soil

CHRYSANTHEMUMS AND POMPONS

Old and New Soils, Planting Distance, Pinching

W. W. WIGGIN

EFFECT OF OLD AND NEW SOILS ON GREENHOUSE FLOWERS

The soil that a florist uses has a great deal to do with the success or failure of the crop. The cost of changing greenhouse soil each year is high. If it were possible to retain the same soil over several seasons and still be sure of a healthy crop, the grower could save this additional expense. Some growers find it difficult to secure good sod with which they can compost manure to refill their houses each year.

This article is a preliminary report of the "Old-vs.-new-soil experiments" carried to date, a complete report of which will appear later.

Two raised beds, 6 by 50 feet located side by side in the greenhouses were used. One of these beds contained soil on which chrysanthemums had been grown for two years, followed each year by snapdragons, stocks, calendulas, and other cut flowers (old soil). The other bed was filled with soil that had been composted similarly to the old soil, but had grown no previous greenhouse crop (new soil). The old soil received a good application of barnyard manure and was then sterilized by the tile method of steam sterilization.

Seven varieties of chrysanthemums and five of pompons were set across the two beds, an equal number of each variety being set in each bed. The two beds received as nearly the same treatment in regard to fertilizer and other cultural practices as possible to give them.

Table 1 gives the results of the 1927 fall crops of chrysanthemums. Diameter of blossoms and length of stems in inches only are given as there were no visible differences in general health of the plants on the old and new soils.

It can readily be seen that the diameter of blossoms was not affected to any great extent. Three varieties gave larger blossoms in the old soil, three gave larger blossoms in the new soil, and for one variety there was no difference. The difference in returns for the slightly larger blossoms would in no way warrant a change of soil under the above conditions.

With all of the varieties the new soil gave longer stems than the old soil. This increase was 2 inches for the Glorious variety and 12 inches for the Golden Glory.

TABLE 1.—Chrysanthemums Grown on Old and New Soils

Variety	Av. diameter Old soil	Av. diameter New soil	Average stem length Old soil	Average stem length New soil
Chrysolora	6.1	6.1	36	39
Golden Glory	5.9	5.6	23	35
Glorious	5.9	6.0	31	33
White Chieftan	4.2	4.1	29	32
Pink Chieftan	4.6	4.5	31	35
Thanksgiving Pink	5.1	5.3	34	39
Louise Pockett	5.8	6.5	39	44

Stem length can be increased by proper nutrition, but it is also determined to a great extent by the time the cuttings are taken, and the date that the plants are set in the benches or beds. If a florist finds that a certain date for taking cuttings and setting the plants does not give the desired length of stem, this can be remedied in most cases by moving the setting date forward. If the soil does not carry sufficient plant food for normal growth, however, early setting will not produce the desired increase.

In view of these findings a chrysanthemum grower would not be justified in changing his soil at the end of even the third year if facilities are available for proper sterilization of the soil, and his crop is being grown in beds.

Table 2 gives the results secured when five varieties of pompons were grown under similar conditions to the chrysanthemums.

TABLE 2.—Pompons Grown on Old and New Soils

Variety	Average number of shoots		Average total number flowers		Average length of stem	
	Old soil	New soil	Old soil	New soil	Old soil	New soil
Golden Feather	5.8	7.1	25	28	22	23
Blanche	5.6	5.4	31	27	22	22
Mariana	3.3	3.7	18	18	18	19
Bronze Buckingham	5.1	5.3	22	24	12	16
Mrs. Buckingham	4.8	5.4	22	23	14	16

It will be noted that the new soil gave an increase in average number of shoots and total number of flowers per plant in four out of five varieties. The new soil gave an increase in the average stem length with four varieties, and the old and new were equal in the case of the fifth variety.

Returns were figured for the pompons per square foot of bench space, on the basis of 25 shoots to a bunch, and a price of 75 cents per bunch. Of course 25 shoots are not necessary for a bunch of some of the varieties, which would make the returns higher in reality. The old soil gave a return of 14.7 cents and the new 16.3 cents per square foot for the pompon crop, or a return of 1.6 cents per square foot in favor of the new soil.

With a bed 6 by 50 ft., or of 300 sq. ft., this gave an increase for the new soil of $4.80. A grower could not compost and change the soil for anywhere near this small increase in returns.

A reader would infer from this discussion that old soil is the most desirable. This is far from the truth in some cases. Where sterilization is not available it will be found that root rots and other disease and insect troubles become very serious on soils that have been set to the same crops for several seasons. Even with sterilization available, a change may prove economical, after a soil has been used for many years.

The foregoing discussion applies only to beds or raised beds. Where raised benches are used an entirely different situation arises.

Soil on a raised bench dries out during the hot days of summer and seems to loose physical qualities that are very difficult to regain.

In the Station greenhouse there are three raised benches, 6 by 50 feet, filled with a soil that had grown carnations for two seasons previous to 1927-28. This soil was again set to carnations in the fall of 1927. These benches are divided into 16 different plots, and each plot, except the three check plots, receives a different treatment. Organic and inorganic fertilizers, different soil modifiers, and combinations are being tried.

This work is not completed but the results so far indicate that the crop on the old soil, regardless of treatment, will not be anywhere near what would reasonably be expected from a new compost soil. Previous experience with various cut flower crops grown on old soil in raised benches bear out these conclusions.

No practical method has been developed to sterilize a raised bench, except by formaldehyde, without removing the soil from the bench. If removal is necessary it is believed that new soil should be placed in the benches, and the old soil used for potting, after it is sterilized and had more humus added to it. The costs of preparation, removing, and refilling the benches, and of modifying the old soil to use for pot plants are being studied. These studies should show the reduction in yield from the use of old soil, the cost of

composting and refilling the benches and beds, and the value of old, modified soil for pot plants. From them a grower should be able to determine for himself, his own definite soil problem.

CONCLUSIONS

1. New unsterilized soil in raised beds did not give enough increase in size of chrysanthemum blossoms over those grown on a sterilized soil that had grown chrysanthemums for two previous seasons to warrant the expense of changing the soil.

2. New soil gave increases of 2 to 12 inches in stem length of chrysanthemums over the old soil, but it is believed this increase in stem length can be secured by earlier planting or by the use of a proper fertilizer, much cheaper than by changing the soil.

3. New soil gave increases in the average number of shoots per plant, average total number of flowers, and average stem length, over the old soil with pompons.

4. The increase in return per square foot of bench space of 1.6 cents for the pompons would not warrant a change of soil under the conditions in this experiment.

5. These conclusions apply only in the case of beds. It is believed that even with these a change of soil in some cases would be beneficial.

6. Where raised benches are used the soil should be changed each year.

7. Tho a grower has never experienced difficulty in growing crop after crop on the same soil, even without sterilization, crop failures are so costly that every precaution should be taken to eliminate them.

THE EFFECT OF PLANTING DISTANCE ON YIELD OF POMPONS

The proper spacing of individual plants to secure the maximum return from the area occupied is an important consideration with all crops. This becomes of increasing importance with crops that are grown under glass, as a greenhouse generally represents a greater investment per given area than an equal area not covered with glass. With this in mind experiments were carried on during the fall of 1927 with two varieties of pompons and one variety of anemone chrysanthemums to determine the effect of planting distance on the yield, growth, and general vigor. This is a preliminary report of this work, as it will be continued.

Forty plants of the Wells Late Pink pompon were set 10 by 10 inches and an equal number 10 by 14 inches. With the exception of the difference in planting distance, the two plots were treated alike thruout the experiment. Table 3 gives the results of the two planting distances on this variety.

TABLE 3.—Wells Late Pink Pompons, Average Growth and Return

Planting distance	Shoots per plant	Stem length	Flowers per stem	Flowers per plant	Returns per sq. ft.
Inches	*No.*	*In.*	*No.*	*No.*	*Cts.*
10 by 10	8.1	25	3.1	25	34.1
10 by 14	8.4	28	3.3	28	26.8

The larger planting distance gave an increase in all of the columns with the exception of the returns per square foot. Growers generally are aware that a greater planting distance gives a better development of the individual plants with the majority of crops. It is the return per square foot under glass that is generally taken as a basis for measuring profits in greenhouses. It will be noted that the greater return was derived by the closer planting, as there were enough more plants by this method to a given area to more than make up for the slightly higher return per plant, when they were set farther apart.

Returns were calculated by taking 25 shoots as a bunch and 75 cents as the price per bunch. Some varieties would not require this many shoots per bunch, so the figures would not hold good in calculating returns for different varieties, or pompon returns in general.

In the experiment with the Sunshine variety of anemone chrysanthemum, 56 plants were set at 10 by 10 inches, and the same number 10 by 12 inches, and 10 by 14 inches. Table 4 gives the results secured with this variety.

TABLE 4.—Sunshine Anemone Chrysanthemum, Average Growth and Return

Planting distance	Shoots per plant	Stem length	Flowers per stem	Flowers per plant	Returns per sq. ft.
Inches	*No.*	*In.*	*No.*	*No.*	*Cts.*
10 by 10	9.3	22.0	4.3	40	41.7
10 by 12	10.1	21.8	4.6	47	41.7
10 by 14	13.7	21.3	3.7	51	37.5

The Sunshine variety gave about the same results as the Wells Late Pink variety. The 10 by 10- and 10 by 12-inch plantings gave the same return, 41.7 cents per square foot. This was a slight difference of 4.2 cents in their favor over the 10 by 14-inch distance.

In the same manner and at the same distances as the Sunshine, 48 plants of Christmas Gold, a pompon chrysanthemum, were set; namely, 10 by 10, 10 by 12, and 10 by 14 inches. Table 5 gives the results.

In Table 5 the stem length is found to be greater with the close planting. This is no doubt due to crowding. It is very difficult to determine the reason for the number of flowers per stem and the total number per plant being greater with the closer planting. The Christmas Gold variety was apparently the most crowded of the three varieties by the 10 by 10-planting distance. A return nearly one-third greater per square foot was secured for the 10 by 10-distance as compared with the 10 by 14-distance.

TABLE 5.—Christmas Gold Pompon, Average Growth and Return

Planting distance	Shoots per plant	Stem length	Flowers per stem	Flowers per plant	Returns per sq. ft.
Inches	*No.*	*In.*	*No.*	*No.*	*Cts.*
10 by 10	17.3	20	6.6	115	94.7
10 by 12	19.3	19	5.3	103	62.5
10 by 14	16.2	15	5.4	89	50.0

These increases as figured per square foot may not seem significant but when figured for a large area the differences become more striking. For a greenhouse 32 by 100 feet, with two-thirds of the area utilized as a growing space (This is the average amount for a greenhouse with walks running around the outside of the beds), the following returns were secured for the three varieties.

TABLE 6.—Calculated Returns for Greenhouse 32 by 100 Feet

Variety	Planting distance		
	10 by 10 in.	10 by 12 in.	10 by 14 in.
Wells Late Pink	$ 739.68	....	$ 563.87
Sunshine	853.31	$ 771.84	817.63
Christmas Gold	1592.99	1339.90	1072.00

These figures must not be taken as a comparison of returns from varieties. As stated before, they were calculated by taking a standard number of stems and blossoms (as figured from the average of all varieties) as being required for a bunch. It would not take as many of the Sunshine to make a bunch in reality as it would of the Christmas Gold. Therefore a grower would receive nearly the same returns for the two varieties.

It seems from the foregoing figures and discussion that the closer planting would be advisable. With the varieties used, and under the conditions of this experiment, this undoubtedly is the case.

A few precautions, however, should be taken. The Christmas Gold variety under the close conditions started to mildew badly. The plants were dusted with sulfur as soon as it was noticed, which prevented a further spread of the disease. In the close plantings some of the lower leaves on all of the varities turned dark. This did not develop high enough on the stems to reduce the price. There were possibilities, however, of both troubles becoming serious if proper cultural practices had not been followed. Without doubt disease and insect troubles are more likely to become serious under the more crowded conditions.

Each grower also may have a different growing condition. Distances that would be adequate on a poorer soil would not be sufficient with the more abundant growth produced on a good soil. Different amounts of water and fertilizer, and changes in general cultural conditions are factors in choosing the proper planting distances. Close planting up to a certain point should prove profitable but beyond this it may be decidedly detrimental.

CONCLUSIONS

1. The proper spacing of plants to secure the maximum return per square foot under glass is an important consideration with greenhouse crops.
2. With three varieties of pompon and anemone chrysanthemums 10 by 10-inch spacing gave larger returns per square foot with all varieties than did the 10 by 14 distance.
3. Injury from diseases and insects is more likely to occur when plants are set close together, lack of sunshine and a circulation of air being responsible for the diseases and a better place to hide unnoticed and harder control conditions being responsible for the insect trouble.
4. Growers must determine more or less for themselves the distances that give them the best results under their own particular growing conditions.

DATE OF PINCHING POMPONS

Altho pompons have become of increasing importance among the greenhouse flower crops during the last few years, yet very little information is available on some of the phases of their culture.

The Ohio Station has been doing some investigational work to learn the effect of different dates of pinching the pompons on number of stems, length of stems, and number of blossoms.

The varieties used were Muskoka, Wells Late Pink, Sunshine, Christmas Gold, Golden Feather, Blanche, Mariana, Bronze Buckingham, and Mrs. Buckingham.

Equal numbers of these varieties were planted in two 7 by 50-foot raised beds in the Station greenhouses. The plants were all pinched at the same time while they were in pots and in the beds up to August 10. One-fourth of the plants were pinched for the last time on that date, and an equal number at three 10-day intervals thereafter on August 20, September 1, and September 10, respectively.

Table 7 gives the results.

TABLE 7.—Pompon, Date of Pinching, Average Number of Shoots, Flowers, and Stem Length

Variety	Last pinching	Shoots	Total flowers	Stem length
	Date	*No.*	*No.*	*In.*
Golden Feather	Aug. 10	6.8	35	27
	Aug. 20	6.1	26	24
	Sept. 1	6.2	22	20
	Sept. 10	6.7	23	21
Blanche	Aug. 10	5.3	33	24
	Aug. 20	5.4	27	23
	Sept. 1	5.6	29	21
	Sept. 10	6.1	30	22
Mariana	Aug. 10	3.5	17	21
	Aug. 20	2.5	15	20
	Sept. 1	4.9	22	20
	Sept. 10	4.0	23	21
Bronze Buckingham	Aug. 10	5.1	24	15
	Aug. 20	4.8	21	14
	Sept. 1	5.9	25	15
	Sept. 10	5.6	21	15
Mrs. Buckingham	Aug. 10	6.3	29	16
	Aug. 20	4.6	18	14
	Sept. 1	4.9	23	16
	Sept. 10	4.6	20	15
Muskoka	Aug. 10	8.8	Disbudded	45
	Aug. 20	8.0		38
	Sept. 1	8.5		32
	Sept. 10	9.1		28
Wells Late Pink	Aug. 10	8.2	28	30
	Aug. 20	9.0	29	27
	Sept. 1	8.1	25	25
	Sept. 10	7.6	29	21
Sunshine	Aug. 10	8.9	57	25
	Aug. 20	9.5	41	22
	Sept. 1	11.7	43	21
	Sept. 10	11.6	45	19
Christmas Gold	Aug. 10	16.0	95	20
	Aug. 20	16.6	100	19
	Sept. 1	19.5	108	18
	Sept. 10	18.3	111	16

The most striking differences were those in stem length. This was particularly true with the later varieties, such as Muskoka, Wells Late Pink, Sunshine, and Christmas Gold. These varieties gave the longest stems when pinched for the last time on August 10, and the stem length was decreased by each successive pinching. Only one variety, Mariana, gave longer stems for the last pinching than for the first.

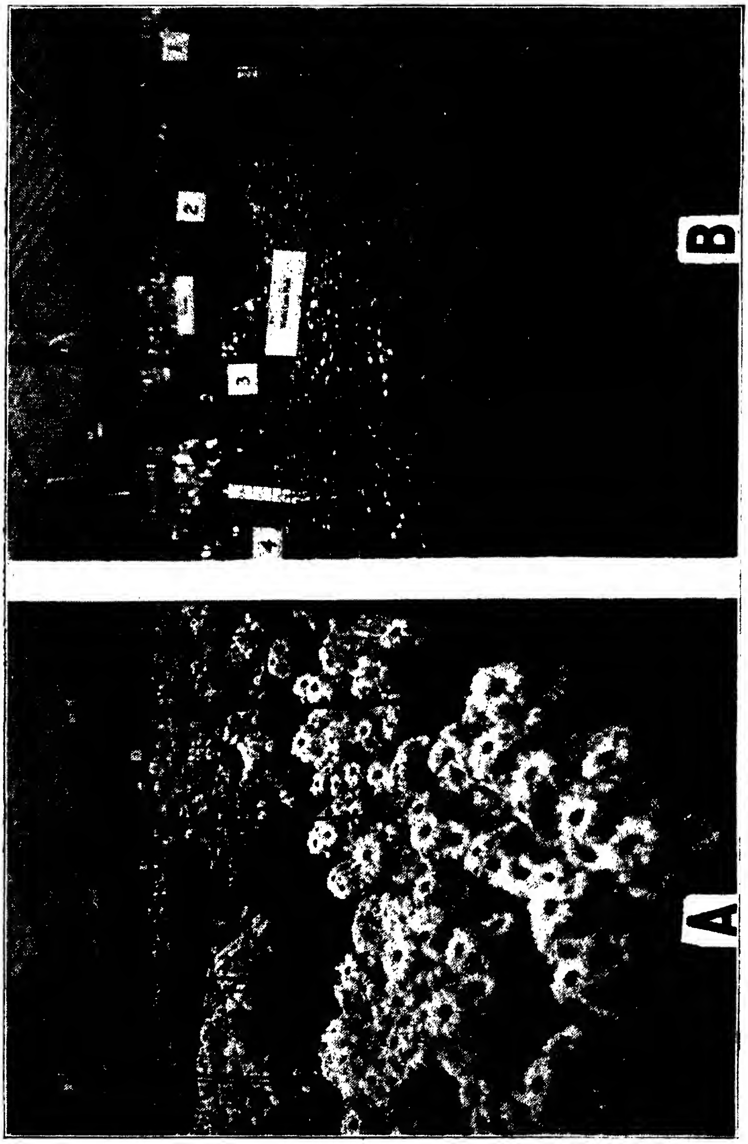
There was a tendency for the more excessive pinching to give a greater number of shoots. Six varieties gave more shoots from the greater number of pinchings, while three had more shoots when pinching was discontinued August 10. Six varieties gave a larger average total number of flowers per plant when pinching was discontinued August 10.

Continued pinching in the majority of cases then gave a larger number of shoots and a smaller average number of flowers per plant. Altho it was sometimes difficult to notice other differences at harvest time, this point was very apparent. The small number of flowers to a shoot in the late pinched rows made the cut from these rows of decidedly poorer quality than the cut from the earlier pinchings.

Another point in the data worthy of notice is the fact that the outside rows that were treated, namely, the August 10 and September 10 pinchings, were nearly always better than the August 20 and September 1 pinchings. A guard row was grown around the bed. Apparently the growing conditions of the outside rows were still enough better to make a difference in number of shoots per plant and in the average number of flowers per plant.

The beds, as stated, were 7 feet wide. This is too wide for practically any flower crop that is grown commercially. As seen from the data, plants on the inside of wide beds do not develop as well, probably due to poorer light, atmosphere, and moisture conditions. Anyone who has worked wide beds or benches knows that more labor is involved and that it pays to give careful attention to the width of beds. The returns may seem greater with the wider beds, but when labor and the quality of crop is considered this may not be found to be the case.

Length of stem in pompons can be determined by the time the plants are set in the beds and by fertilizers in addition to time of pinching. If they are set early the stem length will be sufficient and can even be too great for the best culture. Pinching as shown above would help to overcome too early setting in the beds.



A—Some of the pompons used in the experiments
B—Difference in length of stems could be noticed in the beds

Table 8 gives the results when all the varieties are summarized.

It would seem that each variety tended to produce about the same number of flowers regardless of the time pinched. Pinching late only tended to make more stems, and therefore fewer flowers to a stem. Early pinching would seem to be preferable.

TABLE 8.—Pompons, All Varieties, Date of Pinching, Average Number of Shoots and Flowers per Plant and Length of Stem

Date pinched	Shoots per plant	Flowers per plant	Length of stem
	No.	*No.*	*In.*
Aug. 10	7.54	38.2	25.2
Aug. 20	7.35	33.3	24.9
Sept. 1	8.18	35.4	20.9
Sept. 10	8.33	35.7	19.9

CONCLUSIONS

1. There was a tendency in the pompons to give better results when pinching was not continued too late in the season.

2. Pinching increased the number of stems with most varieties.

3. Continued pinching tended to decrease the number of flowers to a plant. There were fewer flowers to a stem.

4. The sooner pinching was discontinued the longer were the resulting stems, particularly with late varieties.

5. Pinching may be used to keep down excessive stem length when the pompons are set too early.

6. Different varieties of pompons should be treated differently in regard to pinching, for best results.

EARLY CABBAGE RESISTANT TO THE YELLOWS DISEASE

R. C. THOMAS AND ROY MAGRUDER

About eight years ago it became evident that the yellows disease was slowly but surely spreading in the Marietta truck section and seriously threatening the growing of early cabbage. Even then profitable yields could not be obtained from some fields, neither has it been possible since then to mature satisfactory crops of early cabbage of the ordinary commercial strains on those fields. The need for an early strain resistant to the yellows was clearly manifest.

In 1920 and 1921, individual plant selections that showed some resistance were taken from badly diseased areas and seeded the following season. The progeny from these selections showed considerable resistance when compared with the commercial strains in current use. In 1922 one head of Burpee's Early Forcing that appeared to possess a marked resistance was added to those reserved for seed. During the following three years the seed from the selections of each season was bulked together and new selections made from the standpoint of resistance to the yellows with only secondary regard for type.

About 100 heads were successfully carried thru the winter of 1924-25 and planted the following spring on the truck farm at Marietta. These seeded heavily. In 1926 samples of this seed were distributed to nine different growers in the vicinity of Marietta for the purpose of making an extended trial of the resistance of the strain in soil carrying the yellows disease. The merit of the selections from the standpoint of resistance to yellows is indicated in Table 1.

TABLE 1.—Results of Tests With Resistant and Commercial Strains on Diseased Soil

Test number	Resistant selections		Commercial strain	
	Total number plants	Percent diseased	Total number plants	Percent diseased
1	1080	None	1101	37.3
2	423	0.7	646	22.4
3	284	2.8	267	22.8
4	75	1.3	73	39.7
5	522	None	519	14.8
6	172	None	173	46.8
7	184	1.1	169	39.6
8	318	0.9	292	72.6
9	600	0.6	All dead no count	100

CHARACTERISTIC OF STRAIN

The strain shows considerable variation as may well be expected since no line breeding has been followed. The high degree of resistance to the yellows, however, seems to be fixed (Fig. 1). It possesses a marked vigor over commercial strains that is noticeable even in the seedling stages. The leaves are heavy, bluish green in color, and slightly recurrent at the tips. The heads show the most marked variation (Fig. 2). Some are oval closely resembling the Wakefield type, others are round like the Copenhagen, and some are slightly flattened on top like the Danish Ballhead. The average size for the strain falls between the Copenhagen and Golden Acre, yet heads of a given size are heavier and more compact. Crates of the resistant strain weigh from 10 to 20 pounds more than either of the other two varieties when grown under the same conditions and harvested at the same time.

Fig. 1.—Middle row, Copenhagen cabbage, 64 percent of plants produced no marketable heads. Resistant stock on both sides (Washington County Truck Experiment Farm 1926)

In date of maturity the resistant strain is about a week or ten days later than the Golden Acre and does not develop as uniformly as good commercial strains, altho in most cases the resistant strain could have been harvested earlier with profit. It does not show a change in color on approaching maturity, characteristic of certain other varieties, and it is, therefore, necessary to handle the heads in order to determine their stage of development. In some instances the resistant strain was harvested at the same time as the commercial varieties, in spite of the fact that its leafy, vigorous type of growth presents the impression that it is decidedly later in reaching maturity.

The resistant strain holds in good condition longer than any other strain with which it has been grown in comparison.

The desired degree of resistance has been obtained. Work is now well under way for the development of more uniform and satisfactory types of heads. When this is accomplished seed will be available for general distribution.

Fig. 2.—Showing variation in head type of Ohio Early Resistant cabbage as grown in 1926. Note oval, round, and slightly flattened shape

PAPER MULCH FOR THE GARDEN

ROY MAGRUDER

Following a series of successful tests of mulching pineapples in the Hawaiian Islands with an asphalt-treated paper, the idea spread to this country where the material has been recommended for use in the culture of vegetables and some nursery plants.

This article reports some preliminary experiments with mulching paper made during 1924 and 1925 in the Experiment Station gardens at Wooster.

Materials and methods.—An asphalt-impregnated and -covered felt paper, 18 inches in width, perforated, and weighing 30 pounds per 500 square feet, was used according to the suggestions made by the manufacturer.

The rows were 3 feet apart for all crops except tomatoes and cucumbers which were 4 feet. Sweet corn was planted in hills 2 feet apart in the row and thinned to two stalks per hill. Cabbage, tomatoes, and peppers were set 2 feet apart, the tomatoes being pruned to a single stem and tied to a stake. Eggplants were given 3 feet of space. Cucumbers were thinned to one plant per hill, 2 feet apart. Beans were planted in hills 1 foot apart and thinned to two plants per hill.

All crops were harvested when in marketable condition except the bush lima beans which were allowed to become dry. Yields of these are based on the weight of dry shelled beans per hill.

The cultivated plot with which the paper mulch was compared was cultivated weekly with a horse cultivator adjusted to work the soil to a depth of approximately two inches.

Weather conditions.—The May to September period in 1924 was unusually wet and cool while the same period in 1925 was unusually dry with about normal temperature. The two seasons were extreme and opposite in character which is largely responsible for the variable results obtained.

Effect on yield.—From the yield records, Table 1, it will be seen that in 1924 tomatoes and beans were the only crops to be benefitted by the paper mulch. It reduced the yields of sweet corn and cabbage. In 1925, however, it produced almost as large or larger yields of every crop except tomatoes. There is no adequate explanation for the reduced yield of tomatoes.

Effect on earliness.—The earliness, as indicated by the percentage of total yield harvested before an arbitrary date, of all crops except tomatoes, peppers, and early cabbage (1924) was increased by the paper mulch. This effect was most pronounced upon eggplants, cucumbers, snap pod beans, and late cabbage.

By comparing pounds of marketable produce harvested during the early period it was found that mulched eggplants and cucumbers produced about six times while Bountiful beans and Succession cabbage produced twice as much early fruit as the cultivated plot. In 1924 the first picking of snap pod beans was more mature on the mulched plot, which could have been picked seven days before the cultivated plot.

Effect on soil temperature and moisture.—The temperature of the soil 3 inches deep was higher during the night and early morning under the paper mulch than in the cultivated ground. The soil moisture in the upper 7 inches of soil was also higher on the mulched plot.

Effect on germination.—Seedlings appeared both years two or three days earlier on the paper mulched plot. In 1925 it was especially advantageous for the cucumbers as can be seen in Figure 1.

Effect on weeds.—Non-perforated paper prevents the growth of weeds in the area covered but it is necessary to pull by hand the few weeds which come up in the row or around the plants.

Suggestions for use.—For the small home garden two widths of paper may be used: a 1-foot width for narrow row crops such as radishes, lettuce, onions, beets, and carrots; and a 2-foot width for cabbage, tomatoes, peppers, eggplant, beans, and sweet corn planted in 2-foot rows.

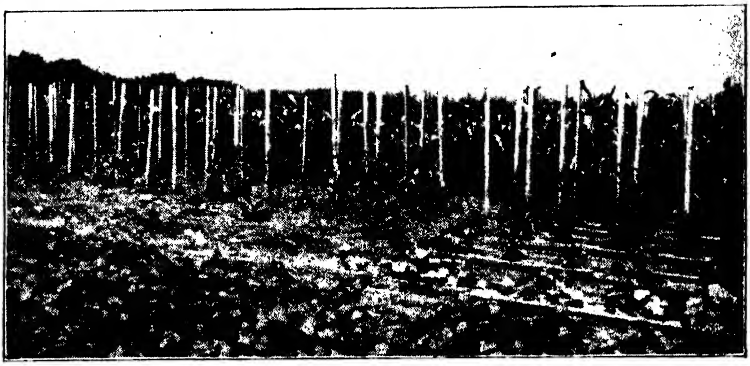


Fig. 1.—Cucumbers and tomatoes at left not mulched; at right, paper mulch held in place by tomato stakes

Tomatoes will need to be pruned and staked if grown this close together each way. Two stalks of corn 2 feet apart each way will not be too close for most garden varieties. Vine crops may be planted in 4-foot rows along the side of the garden, so they can spread toward the fence row. Two of the 2-foot strips can be spread between these rows.

The ground should be leveled off and rows planted an inch or so farther apart than the material is wide. This is to provide a narrow strip of uncovered soil over the row thru which the seedlings may emerge. The paper may then be unrolled between the rows and securely fastened in place by laying narrow boards, stones, or other weights along the edges; by thrusting wire wickets similar to those used for croquet into the soil near the edge of the strips; or with building lath held down by wire wickets.

Asphalt paper mulch may possibly be of value to the home gardener, because of the saving of labor, even tho the yields may not be increased. By following this system of culture a few hand weedings in the row are all the labor required after planting until harvesting. Then the produce is relatively free from dirt, and, because of its rapid growth, usually of high quality.

The largest benefits from the use of paper mulch may be expected from the early warm season crops and during seasons of mid-summer drought.

TABLE 1.—Effect of Paper Mulch on Yield of Vegetables, Pounds per Hill or Plant, 1924 and 1925

Crop	Variety	Year	Cultivated	Paper mulch	Increase or decrease(—) for paper mulch, percent
Sweet corn	Stowells Evergreen..	1924	3.25	2.63	—19
	Stowells Evergreen..	1925	2.39	2.95	23
	Golden Bantam	1925	1.18	1.10	—6
	Country Gentleman.	1925	1.75	2.17	24
Tomato	Bonny Best	1924	6.65	8.28	24
	Bonny Best	1925	7.39	5.56	--24
	Greater Baltimore...	1924	8.02	9.03	12
	Greater Baltimore...	1925	5.29	3.87	—26
Cabbage	Early Copenhagen ..	1924	4.30	2.44	—43
	Early Copenhagen ..	1925	2.24	2.20	—1
	Succession...........	1924	5.04	4.85	—3
	Succession..........	1925	3.24	5.26	62
Dry lima beans	Henderson's Bush...	1924	.062	.085	37
	Henderson's Bush..	1925	.186	.200	7
Snap pod beans	Bountiful............	1924	.840	.947	12
	Bountiful	1925	.610	.731	19
	Webber Wax........	1924	.730	.712	—2
	Webber Wax.......	1925	.638	.682	6
Cucumber	Early White Spine..	1925	5.22	7.26	39
Peppers	Ruby King..........	1925	.69	1.12	62
Eggplant	Black Beauty	1925	4.9	5.10	4

FERTILIZERS FOR TOMATOES

DONALD COMIN

In 1922 the Station started to develop a system of soil treatment in the growing of truck crops that would maintain or increase fertility and crop production. The effect of the use of certain cover crops, lime, commercial fertilizers, and manure and combinations of these for the years 1922 to 1925, inclusive, are reported here.

A tract, 120 by 520 feet, of fine textured silt-loam soil was chosen for the experiment. Various field crops with no manure, but cover crops had been grown, and lime used as a soil amendment.

The rotation in the experiment includes early sweet corn, garden beans, early cabbage, and canning tomatoes. A soybean cover crop has followed each cabbage harvest and at the same time drilled between the rows of corn and beans on designated plots. Thus, with the garden bean crop in the rotation, leguminous crop

was grown three years out of four on certain plots. A winter cover crop of rye was grown each year on all the plots to reduce soil erosion and add humus.

The individual treatments were applied to twelve 1/10-acre sections extending across the four divisions of the rotation. This forms 4 1/40-acre plots receiving the same treatment but growing a different crop. In addition the south half of each plot was limed each year at the rate of 1000 pounds per acre. Plots 1, 4, 7, and 10, to be used as checks, were left untreated with the exception of the lime and cover crops. Thus there are 64 individual plots on which records are kept.

TABLE 1.—Tomatoes, Effect of Fertilizers and Manure

Treatment and 4-year Average Yield and Increase per Acre, 1922-1925

Plot No.	Treatment	Increase above untreated plots				4-year average		
		1922	1923	1924	1925	Yield	Increase	Increase
	Lb.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Lb.*	*Lb.*	*Pct.*
3*	Manure, 8 ton..............	240.9	55.5	61.4	135.0	28,903	14,042	123.2
5*	Superphosphate†, 300; Muriate potash, 75	124.1	0.3	−8.0	92.6	19,587	4,713	52.2
6	Manure, 8 ton; Superphosphate, 320	107.7	103.5	4.6	137.0	25,656	10,740	88.2
8	Nitrate soda, 125; Superphosphate, 300; Muriate potash, 75	35.1	121.4	40.2	95.0	25,460	10,117	72.9
9	Nitrate soda, 250; Superphosphate, 600; Muriate potash, 150	64.0	145.1	51.9	97.8	28,696	12,968	89.7
11*	Ammon. sulfate, 94.6; Superphosphate, 300; Muriate potash, 75	57.4	12.0	47.9	43.4	22,837	6,723	40.2
12*	Superphosphate, 300; Muriate potash, 75; Lime, 1000	0.5	50.5	--25.2	52.2	18,351	2,237	19.5
	Average yield four check plots..................	9,900	13,381	23,675	13,863	15,205	....	....

*Plots seeded to soybean cover crop. †All superphosphate 16 percent.

The varieties used were Copenhagen Market cabbage, Early Sugar sweet corn, Marvelous white kidney beans, and Greater Baltimore tomatoes.

Nitrogen.—The addition of 125 pounds of nitrate of soda to 300 pounds of superphosphate and 75 pounds of muriate of potash per acre on Plot 8 produced an increase in yield of 20.7 percent over Plot 5; and, similarly, 94.6 pounds of ammonium sulfate (carrying the same quantity of nitrogen as 125 pounds of nitrate of soda) on Plot 11 produced an increase of 38.7 percent over Plot 5.

It is interesting to note that the increased yield due to 94.6 pounds of ammonium sulfate added to 300 pounds of superphosphate and 75 pounds of muriate of potash was 38.7 percent, or nearly three-fourths as large as from superphosphate and potash used without nitrogen (52.2 percent). The increase from nitrogen on the limed section of these was greater than that from the phosphate and potash.

TABLE 2.—Tomatoes, Effect of Lime

Increased Yield Due to 1,000 Pounds Ground Limestone per Acre

Plot No.	Treatment	Increased yield				4-year average increase	
		1922	1923	1924	1925		
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Pct.*
3*	Manure, 8 ton	408	−1,116	946	4,553	1,198	4.1
5*	Superphosphate†, 300; Muriate potash, 75	360	3,857	5,213	−1,773	1,914	9.7
6	Manure, 8 ton; Superphosphate, 320	1,440	1,768	3,281	−2,848	910	3.5
8	Nitrate soda, 125; Superphosphate, 300; Muriate potash, 75	−480	−2,578	−1,464	− 475	−1,249	−4.9
9	Nitrate soda, 250; Superphosphate, 600; Muriate potash, 150	648	− 664	3,374	4,426	1,946	6.7
11*	Ammon. sulfate, 94.6; Superphosphate, 300; Muriate potash, 75	5,736	7,800	−1,033	2,836	3,835	16.7
12*	Superphosphate, 300; Muriate potash, 75; Lime, 1000	4,392	244	6,421	−1,114	2,483	13.5
	Average, treated plots	1,352	1,511	1,719	1,120	1,425	5.9
	Average, untreated plots	1,278	2,588	1,919	2,023	1,952	12.8

*Plots seeded to soybean cover crop. †All superphosphate 16 percent.

These large increases indicate the value of nitrogen to the tomato. This element is undoubtedly a limiting factor on this soil.

The 19 pounds of nitrogen applied in the form of ammonium sulfate on Plot 11 produced an increase of 40.2 percent, as compared with 72.9 percent from the same quantity of nitrogen applied in nitrate of soda to Plot 8. This indicates the superiority of nitrate of soda to sulfate of ammonia on the unlimed section of this soil. On the limed section the sulfate of ammonia actually gave a 10.1 percent greater increase than nitrate of soda. This is explained by the fact that on a limed soil the acid residue left by sulfate of ammonia, which may be detrimental, is neutralized by the lime application.

Lime.—Lime produced relatively small increases of tomatoes, the average from all limed check plots being 12.8 percent and of all treated plots 5.9 percent. The increase from 2,000 pounds of lime per acre on the south half of Plot 12 was 13.5 percent greater than from 1,000 pounds on the north half. The gain from lime on a few plots has been increasing during the four years and this suggests that larger applications of lime might produce larger yields.

It is interesting to note that 1,000 pounds of lime per acre on the variously treated plots produced varying increases. The range of increase has been from 4.9 percent on Plot 8 to 16.7 percent on Plot 11. The large increase on Plot 11 has been pointed out as due to the beneficial effect of the lime in neutralizing the acid residue left by the ammonium sulfate. No explanation for the detrimental effect of lime on Plot 8 is offered. These figures suggest that lime may have a definite effect on the efficiency of manurial and commercial fertilizers on tomatoes.

Manure.—Manure at the rate of 8 tons per acre on Plot 3 produced the largest yield of any treatment in this test. But 1,000 pounds of a 4-10-7.5 fertilizer on Plot 9 produced a yield only 207 pounds less, and 500 pounds of the same mixture 3443, or about 12 percent less than 8 tons of manure.

Superphosphate.—Supplementing manure with 40 pounds of superphosphate per ton actually reduced the yields (Plot 6). Since nitrogen is the limiting factor for tomatoes in this soil and 8 tons of manure is a relatively light application, this might account for the lack of any increase from supplementing manure with superphosphate in this experiment.

Commercial fertilizers.—Of particular importance, in this time of low cost commercial fertilizers and growing scarcity of animal manures, are the yields obtained from the chemical treatments. An application of 1,000 pounds per acre of a 4-10-7.5 fertilizer (Plot 9) produced a 89.7 percent, or approximately a 6½-ton, increase in yield above the untreated plots. A half application of the same mixture (Plot 8) produced a 72.9-percent, or 5-ton, increase. These increases approximate those resulting from 8 tons of manure and manure plus superphosphate (Plots 3 and 6). The four-year average increased yields when presented on a tonnage basis seem particularly significant.

The application of 1,000 pounds of 4-10-7.5 mixture produced 30 to 80 percent more tomatoes than 500 pounds of the same fertilizer. This would indicate that tomatoes on this soil can profitably use large amounts of a complete fertilizer.

Summary.—Nitrogen is the most important single element in this test. In the production of tomatoes on this soil nitrogen is a limiting factor and should be supplied in all treatments.

There was little difference between ammonium sulfate and nitrate of soda on the limed sections of this experiment. Due to the acid residue left by ammonium sulfate, nitrate of soda produced larger yields on the unlimed plots.

Fertility Plots at Wooster

Superphosphate as a supplement to 8 tons of manure did not increase yields in this experiment at Wooster.

Lime produced small increases on tomatoes; the increase varied with the additional treatment applied to the limed area.

Manure was very effective in increasing tomato yields.

In this test 1,000 pounds of a 4-10-7.5 fertilizer produced 30 to 80 percent more tomatoes than 500 pounds of the same fertilizer.

A SOUTHEASTERN OHIO SILAGE PROBLEM

J. S. CUTLER* AND WALTER MAHAN†

One of the problems in growing silage corn in southeastern Ohio is to have the fields near the barn. This is especially desirable in the hilly section where distance greatly increases the labor involved in hauling the green corn to the silo.

Where two fields are conveniently located, a short rotation (2-year) of corn and wheat or oats may be used, with sweet clover seeded in the small grain to plow down for corn. Often only a single field is conveniently located and the question arises as to the possibility of growing silage corn every year on this field. Unfortunately little information is available in southeastern Ohio to answer this question.

TABLE 1.—Corn Grown Continuously for Silage

Year	Variety	Date planted	Date harvested	Yield, tons per acre
1917	Clarage	May 19	Oct. 8	10.0
1918	Leaming	May 17	Sept. 19	4.7
1919	Leaming	May 19	Sept. 17	7.9
1920	Leaming	May 19	Oct. 12	7.0
1921	Darke County Mammoth	May 19	Sept. 9	8.0
1922	Eureka	May 26	Sept. 28	11.8
1923	Leaming	May 18	Sept. 17	8.9
1924	Leaming	June 5	Oct. 2	7.8
1925	Leaming	May 9	Sept. 9	7.0
1926	Old Virginia	May 12	Sept. 25	16.1
1927	Old Virginia	May 3	Oct. 13	9.1

On the Belmont County Experiment Farm a block of land near the silo has been growing silage corn continuously since 1917. The variety, the fertilizer treatment, the use of a cover crop, and the planting dates have varied from year to year. Each of these factors undoubtedly has had an influence on the final yields. For instance, an earlier variety, such as the Leaming, usually produced a lower tonnage per acre but a better quality silage than a later variety, such as the Old Virginia. The actual pounds of nutrients produced per acre are probably nearer together than the actual tonnage figures indicate. In spite of these variations and the varying seasonal effect the yearly yields may be of some value in indicating the production trend. No attempt is made to analyze the results. The data are presented and the reader may draw his own conclusions.

*Assistant in Agronomy, in charge of outlying experiments. †Superintendent of the Belmont County Experiment Farm.

It might be added that neither corn diseases nor insect pests have ever seriously affected the yields. Weeds, however, have been worse than where a rotation was practiced and manure applied less frequently.

Where silage corn is to be grown continuously on a field the fertility program should be so planned as to meet the fertilizer needs of the crop and at the same time maintain the supply of organic matter in the soil. Such a program should include a liberal application of well-cared-for manure, together with both broadcast and hill or row fertilizer applications for corn and the growing of some sort of a cover crop on the land over winter. A fertilizer treatment of 8 or 10 tons of manure and a broadcast application of 200 to 250 pounds of 20 percent superphosphate and a row application of 100 or 200 pounds of 2-10-6 is suggested. For the two-year rotation, an application of 400 pounds per acre of 2-14-4 on the wheat or oats crop and 100 or 200 pounds of 2-10-6 in the hill or row for corn is suggested. The heavy application on the small grain crop will make for a better stand of the legume used.

Such cover crops as rye, and rye and vetch have proved satisfactory. Where rye is used as a cover crop, early plowing is especially desirable to conserve the moisture supply and to allow the soil to settle before planting. A mixture of sweet clover and vetch seeded at the last cultivation of corn, has given excellent results, but the use of sweet clover necessitates liming on most soils.

THE POSSIBILITY OF PRODUCING IODIZED MILK

C. F. MONROE

In the past few years there has been a strong movement to improve the quality of milk sold as market milk. This movement has been concerned not only with increased sanitation in the producing and handling of milk but also with raising its nutritive value. The discovery of vitamins in milk has played a leading role in arousing attention to its food value and as a consequence has greatly increased the consumption of milk. But it must be remembered that the nutritional merits of milk are by no means entirely dependent on its vitamin content. The value of the proteins, fats, sugar, and minerals in milk must be considered. In fact, milk occupies a prominent place in the diet because of a com-

bination of factors. It has been claimed by some that the nutritive value of milk would be increased if it contained iodine or a greater percentage of iodine.

Sherman, in his book on Chemistry of Food and Nutrition, says, "From present indications, therefore, it appears probable that milk and green vegetables, classified by McCollum as protective foods because of their calcium and vitamin content, will also prove of value as dietary sources of iodine."

The foregoing statement, made by a recognized authority, may lead some to ask the question, Does milk contain iodine? The evidence on this point is not clear. Forbes at the Ohio Station failed to find iodine in 18 samples of milk, Bul. 299, 1916. The normal iodine content of milk as stated by some others* is quite small, ranging from 5 to 10 parts per billion. Leitch and Hendschen, in Biochemistry, 1926, page 115, reported milk as having a much higher iodine content. While McClendon in Physiological Reviews in 1927, claimed that there is a marked difference in the iodine content of milk due to the locality in which it is produced. However, it should be pointed out that the accurate determination of such small amounts of a substance like iodine is exceedingly difficult and that this fact may account for some of the apparent discrepancies.

Work now in progress at the Ohio Station has been in agreement with that of Forbes, in that the presence of iodine in the milk of cows as fed at the Experiment Station has not been demonstrated. This work has been in progress for two years and the milk from 20 cows has been analyzed at varying intervals. Several different stages in the lactation periods have been represented in the work. Also the milk has been produced by cows receiving quite a variety of rations. It is not maintained that the milk from these cows has been entirely free from iodine, but the claim is made that the amount of iodine in the milk must have been lower than ten parts per billion.

The next logical question is, Would feeding iodine to these cows increase the iodine content of the milk? This question is of some practical importance because there are a large number of cows in Ohio at the present time that are receiving this substance in some form. Many dairymen are feeding mineral supplements to their cows, and quite a number of these supplements contain iodine.

*U. S. Department of Commerce, Published Document 967. Van Fellenberg, Mitt a d Gebiete d Lebensmittle U Hygiene, 1923, 14, 161. And McClendon and Hathaway, J. Amer. Med. Assoc., 1924, LXXXII, 1668.

Iodized salt is also fed to cows, and some feeders give their pregnant cows solutions of sodium- or potassium-iodide in order to prevent goiter in the offspring. Then, in a very few instances, iodine is fed to cows to produce iodized milk, and this milk is specially advertised and sold as such. It appears, therefore, that, whether or not we believe in iodized milk, the question is already with us, Is iodine secreted in the milk from cows receiving this substance in the feed?

To answer the question of the possibility of iodizing milk by feeding iodine, certain cows have been given this substance in the form of potassium iodide. At first the potassium iodide was mixed with the salt, which in turn was mixed with grain. Later, a water-solution of the potassium iodide was made and sprinkled over the grain. The latter method is the one now in use. Minimum amounts of potassium iodide have been fed in order to avoid any possible poisonous effect to the cows. The amount fed has been 0.1 gram daily. This contains approximately 0.08 gram (1.2 grains) of iodine. Four of the cows received this amount for one complete lactation period. No ill effect on health, production, reproduction, or vigor of offspring was noted. Six other cows have received potassium iodide for varying lengths of time. Frequent tests of the milk produced by these cows have shown that iodine is in the milk. The amounts have varied approximately from one part in 100 million to one part in 10 million. Apparently only a very small part of the iodine fed appeared in the milk. This would suggest some regulating influence governing the amount of iodine secreted into the milk, at least on this level of iodine feeding.

Check tests were made on the milk of these cows before iodine feeding was started, and the milk of a check group that does not receive iodine has been analyzed at the same time as the milk of the group receiving iodine. Up to the present time we have been unable to detect any iodine in the milk of cows that do not receive this element as a supplement in their feed.

With the aid of Prof. O. Erf, of the Ohio State University, work similar to that with the herd at the Station was conducted in cooperation with a commercial herd near Columbus, O. Six cows were on this test: two received no iodine, two received 2 ounces of dulce (a seaweed), one received 2 grains of calcium iodide, and the other received 2 grains of potassium iodide per day. Samples of milk from these cows failed to show any trace of iodine before the experimental feeding started. After the iodine had been fed for approximately 30 days, samples were again analyzed and the milk from the check cows showed no iodine, while the milk from the four

receiving iodine in one form or another showed traces of iodine, estimated from one part in 100 million to one part in 10 million. In so far as we were able to determine, the form in which iodine was fed made little difference on the iodine content of the milk.

Mio Queen, 631834, age 2 years, 4 months, R. M. record, 8501 pounds milk and 437.28 pounds fat, in 365 days; milked twice a day. Carried calf 211 days. She received 1 gram potassium iodide daily during this lactation and subsequent dry period. Her milk contained iodine (1 part in 10 million). She dropped a 95-lb. calf at the succeeding freshening.

The wisdom of producing milk with a higher iodine percentage may be questioned. It may be pointed out that milk with an extremely low iodine content may be regarded as being as much abnormal as one with a high iodine content. The iodized milk produced by cows fed iodine in the Station herd has not been richer in iodine than milk produced in regions where the feeds are rich in iodine and no supplemental iodine is fed. In these sections iodine in small amounts seems to be a perfectly normal constituent of milk, but in regions where the iodine in the feed given the cow is low, the iodine content of the milk produced may be extremely low or absent.

SEASONAL VARIATION IN THE ESTIMATED GROSS CASH INCOME FROM OHIO'S AGRICULTURAL INDUSTRY

V. R. WERTZ

While primary interest in estimates of income from the agricultural industry is in the size of this income, much importance likewise attaches to the variation in this income from month to month. This seasonal variation of gross cash income is of interest to merchants and public officials as well as to farmers, for merchants must adjust their sales and credit policies in such a manner as to dove-tail with the incomes of their customers, the farmers, and administrators of public funds must likewise adjust the income and outgo of these funds in such a manner as to fit in with the agricultural income.

An Index of the Seasonal Variation in Ohio's Gross Cash Agricultural Income, 1921 to 1927, Inclusive

(Monthly Average, 1921-1927, Inclusive=100)

Estimated gross cash income	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Total (index)	101	92	94	88	94	99	104	102	103	118	107	97
Meat animals (index)	118	90	98	97	96	93	84	82	93	114	112	122
Dairy products (index)	91	88	101	98	115	110	111	102	104	97	90	93
Grains (index)	113	108	82	60	76	75	155	180	97	81	84	89
Poultry and eggs (index)	81	75	89	113	111	110	94	92	97	120	110	109

The total estimated gross income from the sale of Ohio farm products together with the estimated income from four of the major groups—meat animals, dairy products, grains, and poultry and eggs—are shown as seasonal index numbers in the accompanying table. The chart shows the seasonal variation of the estimated total gross cash income and the income from meat animals and grains.

The months in which the total agricultural income has usually been highest in Ohio in the past seven years, 1921 to 1927, have been July to November, inclusive. The months of relatively low income have been from February to June, inclusive.

By separating this total income into its chief component parts it is easily seen why the income normally rises in July and August and in the fall months. The income from grains is highest in July and August. While the usual tendency is for grain prices to decrease in July and August, the quantity sold much more than

off-sets the influence of falling prices, resulting in an income considerably above the average in these two months. It will be seen that the income from meat animals is chiefly responsible for maintaining the income relatively high in October and November. The most stable source of income is from dairy products, which have yielded a relatively high income in May, June, and July. For the period here considered, the estimated income from poultry and eggs reached its highest level in April, May, June, October, November, and December. The income from the sale of wool, which is not shown separately, has also been partly responsible for maintaining the total income at a relatively high level in July. The months of highest income have been October and November. The income from meat animals and poultry and eggs as well as from vegetables, fruits, and sugar beets has been high in these two months.

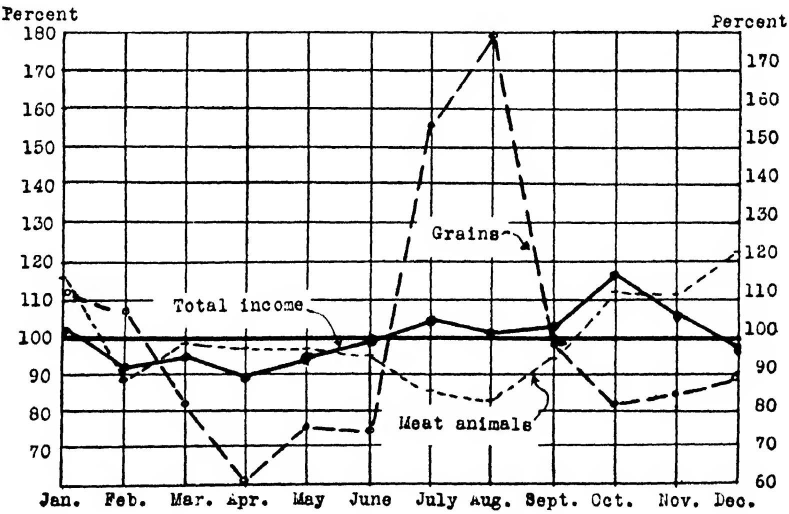


Fig. 1.—Index of seasonal variation in Ohio's gross cash agricultural income, 1921-1927, inclusive

RECEIPTS AND EXPENSES ON OHIO FARMS FOR 1927

J. I. FALCONER

Each year the Department of Rural Economics summarizes several hundred farm account books. At the present time there are at hand records for 113 farms, the books of which were summarized for the year 1926 and also for 1927. The data from these summaries provide some interesting comparisons which are given in the table below. The farms were quite evenly distributed over the State, except that there were few from southeastern Ohio.

In the first place it will be noted that the receipts from sales for the two years were practically the same, being only seven-tenths of one percent higher in 1927 than in 1926. In northwestern Ohio the receipts were 4 percent less in 1927 than in 1926 and in southwestern Ohio slightly more. Cash expenses were 14 percent more in 1927 than in 1926. This increase in expenses was general in all sections of the State, but was especially high in northeastern Ohio where expenses for 1927 averaged 20 percent higher than in the previous year.

Average Receipts, Expenses, and Income per Farm of 113* Ohio Farms

	1926	1927
Cash receipts per farm	$3,920	$3,948
Cash expenses per farm	1,532	1,743
Receipts less expenses	2,388	2,205
Labor income per farm	1,513	1,092

Labor income showed the greatest comparative change. Labor income it might be explained is derived by subtracting from the receipts all the farm expenses and interest on the investment. An increase in inventory of the working capital, which includes livestock, feed, and supplies is considered as an income; a decrease, as an expense. The labor income for the year 1927 was 28 percent less than in 1926. This decrease in labor income was largely due to the shrink in inventories during the year 1927. Poor yields in 1927 of corn and wheat, especially the former, made low feed supplies on hand at the end of the year. Again hog prices were in a slump at the time of the closing inventory. The conditions, however, varied in the different sections of the State. In northeastern Ohio the average labor income in 1927 was 8 percent less than in 1926 while in northwestern Ohio it was 54 percent less.

INDEX NUMBERS OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

Since the first two months of the year there has been a notable increase in the price level of Ohio farm products as a whole. While in 1927 the prices of Ohio farm products tended to sag from January to April, the reverse was true in 1928. From a level of 141 in February, prices of farm products had advanced to 149 in April, five points higher than in April of 1927.

Higher grain prices were largely responsible for this advance. As indicated, however, in the March-April Bimonthly Bulletin this increase in price has not brought a corresponding increase in income, due to the small amount of grain to be disposed of and to the heavy marketing of Ohio hogs in January and February before the price advanced. For the first four months of 1927 the gross cash income from the sales of agricultural products from Ohio farms in terms of index numbers (1924, 1925, and 1926=100) were, 102, 97, 93, and 91, while for the corresponding months of 1928 it was 96, 87, 87, and 85. Thus it appears that the rise in price has not been sufficient to increase the total income over the first four months of last year.

TREND OF PRICES AND WAGES
1910-1914=100

	Wholesale prices all commodities	General wage level N. Y. factory workers	Non-agricultural products U. S.	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Farm products prices Ohio
1913	102	....	105	100	104	100	104
1914	100	100	97	102	102	102	105
1915	103	101	101	100	103	107	106
1916	100	114	138	117	113	113	121
1917	131	129	182	176	140	119	182
1918	188	160	188	200	175	131	203
1919	290	185	199	209	204	135	218
1920	210	122	241	105	237	159	212
1921	130	203	167	116	164	134	132
1922	152	197	168	124	145	124	127
1923	156	214	171	135	166	122	134
1924	152	218	162	134	165	118	133
1925	161	223	165	146	165	110	159
1926	154	228	161	136	170	105	155
1927	149	....	....	....	....	....	147
1927							
May	147	230	150	126	....	....	145
June	146	230	150	130	....	....	147
July	147	328	151	130	174	....	147
August	149	231	151	132	....	....	149
September	152	233	152	140	....	....	149
October	153	231	151	139	173	....	151
November	152	226	151	137	....	....	149
December	152	233	151	137	....	....	145
1928							
January	151	230	151	137	159	....	141
February	151	230	152	135	....	....	141
March	150	233	....	137	....	98	146
April	....	....	....	....	172	....	149

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Ohio Agricultural Experiment Station

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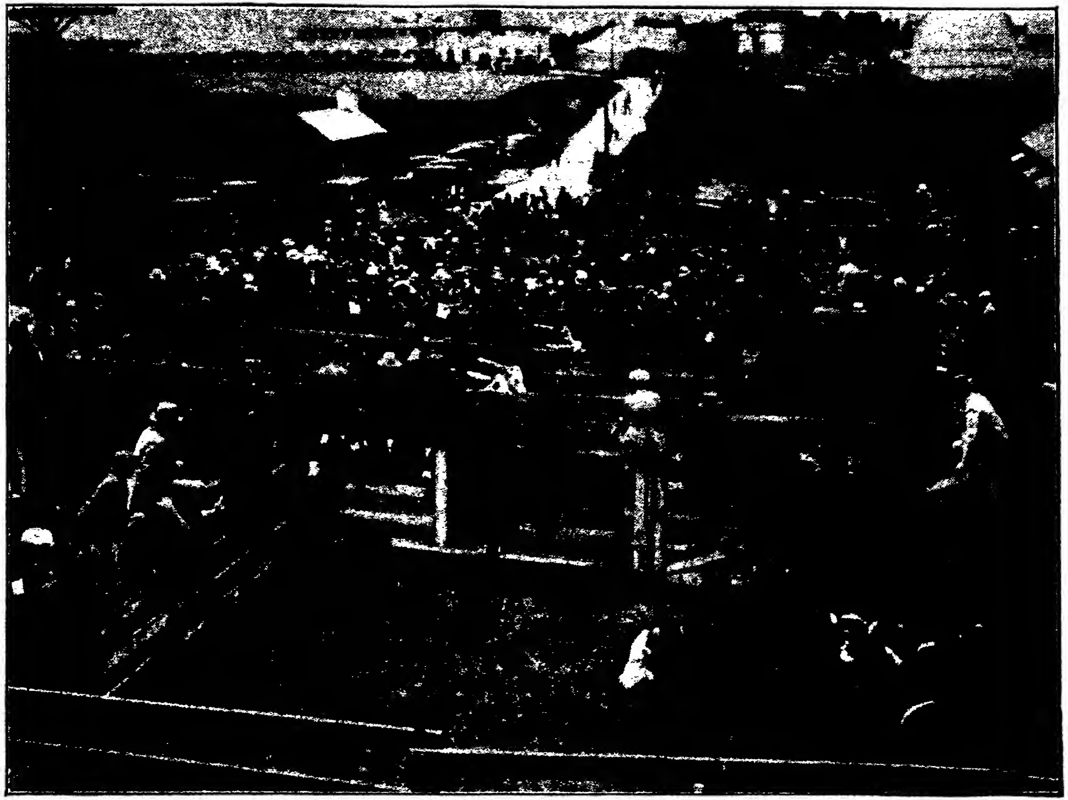
Wooster, Ohio, U. S. A.



At the Cattle Pens, Livestock Day, June 1, 1928

PROCESSING FEEDS

A Study of Certain Processes for Fermenting or Enzymatizing Feeds

A. E. PERKINS AND C. F. MONROE

For several years there has been offered in a commercial way, equipment and material which has been claimed by the promoters to make a great improvement in the quality and effectiveness of the feed supplied to livestock.

It has been claimed that the crude fiber, the most indigestible, woody part of the feed, is attacked in the process and broken down into the simpler, more useful forms of carbohydrates. The cell walls are also said to be broken down making the cell content more digestible. It is claimed that the starches in feeds are converted into maltose, dextrose, or other sugars, thereby improving the quality and palatability of the feeds and increasing their digestibility and usefulness to the animals. The use of roughages treated in this way has been widely advertised to do away with the need of feeding part or all of the grain now commonly recommended. If what is claimed were really accomplished, these processes should greatly reduce the cost of feeding animals.

The equipment used in these processes has taken various forms, including a silo-like tank arranged for feeding the chopped roughage, hot water, salt, and converter in at the top and removing the treated material from an opening at the bottom. A more common form at present is a rectangular wooden vat, either stationary or mounted on trucks, and equipped with perforated steampipes to permit steaming the feeds after the usual soaking with hot water. A small steam boiler or other source of an abundant supply of hot water and steam is essential to any form of the apparatus.

The use of a "converter", "digester", or "starter", which must be purchased direct from the firm manufacturing the equipment, is prescribed in all cases. The presence of various enzymes, for the most part different forms of diastase, in this starter is claimed by the proprietors. It is difficult to define the word enzyme in nontechnical language, but some familiar examples of enzyme action are the curdling of milk by the rennet enzyme in the process of cheese making, and the conversion of starch to sugar by the enzyme diastase in sprouting grains. This is the first step in the process of making beer or other fermented liquor.

An examination reveals the presence of ground malted barley, salt, and various flavoring and tonic substances as the chief ingredient of these converters. Their composition is extremely variable. Three samples supplied by the same firm during the last 18 months, showed a surprising degree of variation for what purports to be a standard commercial product. The sample used in our experiment was fairly efficient as a diastatic enzyme. That is, it possessed the power to convert starch to sugar under proper conditions.

Until recently there have been practically no definite scientific observations recorded which would serve either to prove or disprove most of the claims made by the advocates of these systems of feed preparation.

Practical work in feeding these processed feeds to horses has been reported from the Wisconsin Experiment Station in Bulletin 396 of that station. The Animal Industry Department of our own Station, in a leaflet for Livestock Day, June 1, 1928, reported a feeding experiment with steers in which feeds processed in this way were compared with the original feed prepared in various other ways or fed entire in the usual manner. In neither of the experiments just mentioned was any practical benefit obtained from processing the feeds as recommended by the firm supplying the equipment. In later work with dairy cows at the Wisconsin Station (not yet published) the same conclusion was reached.

Chemical analyses of numerous samples of feeds before and after treatment by this process at the Experiment Station, and of samples obtained at other farms, and also a rather extensive supplementary laboratory study to determine various points in question, were made by the authors during the months of February to June, 1928. Our conclusions from laboratory experiments were verified by large-scale experiments conducted in the commercial apparatus then in use by the Department of Animal Industry in the experiment mentioned above.

These studies lead to the conclusion that neither this nor any similar process now known depending on fermentation, or enzyme action, is capable of breaking down the crude fiber of feeds to any appreciable extent. Enzymes are known in nature, for example, in the bodies and secretions of wood-boring insects and wood-destroying fungi, that will convert crude fiber or cellulose into sugars, but these are not commercially available. This may also be done by other methods such as acid or alkaline hydrolysis but these methods are not now economically practical.

We have been unable to find a single instance where any worthwhile amount of maltose, dextrose, or other reducing sugar has been formed from hay, corn stover, straw or other roughage during treatment by these processes. On the other hand, part or all of the small amount of reducing sugar present in the original materials sometimes disappeared during the process.

Our laboratory experiments revealed two reasons: (1) there is no starch and (2) the enzymes are killed in the process. Either of these taken alone is sufficient to account for the failure to convert the higher carbohydrates of the roughages into reducing sugars, as the process is claimed to do.

The converters used in these processes depend for their effectiveness on enzymes, chiefly some form of diastase. Diastase acts almost exclusively on starch and has no effect whatever on other complex carbohydrates. The roughages contain little or no true starch. The material in the roughage feeds that appears as starch in the ordinary method of analyses is not starch at all but rather pentosans and galactans, other forms of complex carbohydrates, which are entirely unaffected by diastase.

The directions which accompany these processes call for the mixing of the converter containing the enzyme with the feed before steaming and later steaming for varying lengths of time. During this steaming the feeds are heated to practically the boiling point of water, which at this altitude will usually be a few degrees below 212° F., but nearly always above 205°.

Most enzymes are inactivated or killed at temperatures of 190°, or above, and none is known to resist a temperature of 200°. Others are inactivated by temperatures as low as 150°. Carrying out these processes as recommended by the proprietors, therefore, kills the enzyme present in the converter before it has any chance to do its work.

The converter supplied to the Experiment Station was quite efficient as an enzyme in converting starch to reducing sugars, when used under proper conditions. The conditions which must obtain to secure any worthwhile transformation of starch to reducing sugars by means of enzyme action are: (1) True starches must be present in considerable amounts. These are present in large amounts in all the common grains but not to any extent in the roughages. (2) The starch grains must be broken either by fine grinding or some form of cooking, heating, or steaming before much conversion of starch to sugars is possible. (3) This heating must be done and the mixture cooled below the thermal inactivation point

of the enzyme, before the converter is added to the mixture. With the particular converter used in this study this temperature was approximately 185° F. In the case of a sample of Taka Diastase purchased from Parke Davis & Co., the point of inactivation was approximately 160° F.

Little or no heat is generated or given off in the enzymatic cleavage of starch to sugar, so that dependence must be placed either on heat supplied from outside or on a high degree of heat insulation of the material warmed at the beginning, to maintain favorable temperature conditions. Temperatures above 120° F. and below the inactivation point of the particular enzyme employed seem to be most favorable.

Conversion of starch to sugars occurs at temperatures between 60 and 120°, but yeasts and molds are likely to develop under such conditions, destroying the sugars as fast as they are formed and often rendering the feed unpalatable or otherwise unfit for use.

When favorable conditions as outlined above are maintained and the converter is used at the rate of 1 percent of the dry feed, we have been able to obtain as much as 10 percent of sugar in the dry product from materials that contained less than 2 percent of sugar. To do this the mixtures must contain liberal amounts of finely ground grains such as corn or oats. They must be first steamed and then cooled below the inactivation point of the enzyme before the converter is added. They must then be kept at a temperature favorable for the reaction. In the case of uncooked but finely ground mixtures, incubated at the most favorable temperatures, we have been able to get a maximum of only about 5 percent of sugars.

Granting that the conversion of starch to sugars as outlined is practical, the question remains whether such conversion is of physiological advantage to the animal, therefore of any practical advantage to the farmer.

No experiments have yet been reported which answer this question. It is well known, however, that the digestive tract of most farm animals is well supplied with enzymes fully capable of converting starches to sugar. For this reason we would not look for any pronounced nutritional advantage except what might follow an increased consumption of feed, due to its increased palatability. This increased palatability and feed consumption might be caused by the salt and tonic substances added with the converter, also by the sugar formed. The soaking and steaming of some roughages also seems to bring out latent flavors and may perhaps make a considerable improvement in the palatability of the feed. To just

what extent these alterations in the feed may result in practical benefit has not been studied or recorded by impartial observers.

As a first or preliminary step in this direction the writers, with the cooperation of Dr. W. E. Krauss, fed two groups of albino rats on identical rations consisting of corn 43, oats 43, alfalfa 6.5, corn-stover 6.5, and salt 1 parts. The entire feed was wet with an equal weight of water, steamed for one-half hour and cooled. To one-half of this feed commercial converter in amount equal to 1 percent of the dry weight of feed was added and well mixed, no converter of any kind was added to the check ration.

Both lots of feed were then incubated at 130 to 140° for 36 hours, after which they were dried and reground and fed to the rats in an air-dry condition. Under this treatment 10 percent dry weight of reducing sugar was formed in the experimental or converted ration. No sugar whatever developed in the check ration.

As much feed was supplied to each group as would be consumed without undue waste. Individual weights were taken twice a week. Growth was entirely normal and there was little difference between the groups, but such difference as there was favored the check group rather than the one receiving the converted ration. Neither the experiments at the Wisconsin Station with horses and dairy cows nor that at the Ohio Station with steers throws any definite light on this question. In neither case was any considerable amount of sugar formed in the treated feed.

In the experiments at the Wisconsin and Ohio stations only the roughage, which contains no starch, was processed. Also the mixture was steamed after adding the converter. In the Wisconsin experiment with horses, oats were present in the treated material but they were whole and being thus protected by the hull were not affected by the enzyme applied from without. In this case also the steaming was done in such a way as to inactivate the enzyme before it had any opportunity to accomplish its work.

It is difficult to understand how the conversion of 5 or 10 percent of starch to reducing sugars, which our experiments indicate may be expected under favorable conditions, can greatly change the unfavorable results obtained in both the Wisconsin and Ohio experiments.

No charge for equipment, converter, or for fuel and labor was made in either of the experiments cited. To offset these items an improvement in the value of the feed amounting to at least 20 to 25 percent would be necessary. Such slight changes in the composition of the feed as were revealed by our chemical study of the

process under commercial as well as ideal conditions suggest no possibility that so heavy an overhead expense could be borne by the process. Indeed the processed feeds seem scarcely able to compete with similar untreated feeds when no charge whatever is made for the expense and work of processing.

In a survey of several farms where one of these processes was being used, C. C. Hayden made the following report regarding the process:

> Some of the better farmers and feeders who once used the process have abandoned it.
>
> Those who claimed to get the most benefit were for the most part poor feeders whose cattle were kept in cold barns. In some cases the cattle probably were not receiving sufficient water. These conditions would greatly favor the use of a warm moist feed, such as furnished by these processes.
>
> Most of the farmers who claimed to get especially favorable results were subsidized in the form of county agencies and were hence incapable of rendering impartial judgment. Moreover definite records of feeds or production on which to base any reliable judgment were almost entirely lacking.

No claims appear to have been made regarding any effect of the process on the digestibility or availability of the protein of the feeds. A recent German textbook by Klimmer, in discussing the preparation of feeds as practiced in that country, states that any process involving scalding, steaming, or heat treatment of feeds decreases the digestibility of the protein. An older German text by Kellner takes the ground that the digestibility of the protein will likely be reduced and some carbohydrates lost in most processes of this kind.

In summarizing, the fiber of feeds is not broken down by this process. Any increase of sugar even when obtained, is offset by a corresponding loss of equally valuable starch. If there be any change in the status of the protein, it is probably rendered less digestible. There is no suggestion or indication of any significant improvement in the fat, minerals, or vitamins of the feeds due to this process.

Improvement in flavor and increased feed consumption would then seem to be about the only points at which it would be reasonable to expect any decided benefit by treating feed in this way. In the judgment of the writers, this increase of palatability and of sugar content can be much more readily and cheaply obtained by the use of small amounts of feeding molasses.

Molasses can usually be obtained in barrel lots at $40 to $45 a ton, usually a little higher than corn. It can be conveniently used by diluting with an equal volume of water and sprinkling over the roughage or other unpalatable part of the ration. Molasses adds to the ration about 70 percent as much energy value as is supplied by an equal weight of corn, leaving a relatively small amount to be charged for its tonic, conditioning, and appetizing qualities.

Additional attention to the time and method of cutting, curing, and storing the roughages may also in many cases improve their palatability and feeding value more cheaply and with less effort than would be necessary to process the feeds by fermentation methods.

None of the feeding experiments that have been reported have shown any benefit to the animals from processing their feed. Extensive laboratory studies give little indication that sufficient improvement is possible to make any similar process now known of practical value.

The Experiment Station, therefore, must warn against the use of any such process until its usefulness and economy have been estabished by reliable experimentation.

RELATIVE PROFITABLENESS OF LOW AND HIGH PRODUCING COWS

F. L. MORISON

The difference in the profits secured from cows of varying production is brought out in a study of the records of a number of Medina County dairymen who kept cost accounts in cooperation with the Rural Economics Department during a five-year period.* The records of these farmers were divided into four groups, based on the average herd production per cow, as shown in Table 1.

This table shows not only the various quantities and values of feeds and other items of cost per cow in the different production groups, but also the cost per hundred pounds of milk, the return per hour of labor spent on dairy cows, average labor income per farm, and other factors.

*A complete report and discussion of this study is given in Monograph Bulletin 422, Dairy and Other Livestock Costs in Medina County, Ohio, by F. L. Morison.

Cows in herds averaging less than 6,000 pounds of 3.5 percent milk in a year produced this milk at an average cost of $3.08 per hundred pounds at the farm, while those producing more than 9,000 pounds annually had a cost of only $2.29 per hundred pounds. Feed cost per hundred pounds of milk was $1.72 in the low-producing group and only $1.33 in the high-producing group. A cow requires a certain amount of feed to maintain her body and develop a calf regardless of the amount of milk produced. It is the feed that she gets in excess of this maintenance requirement that largely influences her production. Annual feed cost in the highest producing group of herds amounted to $130.33 per cow, or $39.65 per cow more than the feed cost for the lowest producing class. This additional $39.65 worth of feed was accompanied by an increased milk production valued at $119.51, a good return for the investment. Not taking into account the nutrients obtained from pasture, the ration in herds producing less than 6,000 pounds of milk averaged

TABLE 1.—Cost Factors per Cow and per 100 Pounds of Milk in Herds of Varying Production per Cow

Five-year Average 1920-1924, Medina County, Ohio

	Under 6000 lb. milk		6000 to 7500 lb. milk		7500 to 9000 lb. milk		Over 9000 lb. milk	
Farm records........ .... No..	15		17		21		17	
Cow-years........................No..	222.1		185.1		233.5		172.2	
Average production per cow..Lb..	5289		6656		8206		9765	
Return per $1 worth of feed...Dol..	1.56		1.80		1.87		2	
Return per hour of labor.....Dol..	.106		.221		.349		.512	
Labor income per farm.......Dol..	−311.94		−11.70		233.01		684.12	
Cost factors per cow:								
Concentrates:	*Lb.*	*Dol.*	*Lb.*	*Dol.*	*Lb.*	*Dol.*	*Lb.*	*Dol.*
Corn...........................	789	11.93	612	9.93	617	9.83	914	16.21
Oats...........................	530	10.18	571	11.60	568	11.25	922	20.68
Cottonseed meal and oilmeal..	243	7.21	263	7.79	457	12.68	610	18.04
Bran and middlings...........	163	3.07	117	2.42	259	4.53	247	4.31
Other concentrates............	291	7.56	358	9.79	593	16.64	431	9.49
Total concentrates............	2016	39.95	1921	41.53	2494	54.93	3124	68.73
Succulent feed..................	7237	21.41	9979	28.10	9247	27.18	8139	24.07
Hay............................	2019	15.97	2005	15.51	2678	22.57	2827	23.33
Stover..........................	729	2.16	815	2.63	730	2.09	1121	3.59
Pasture..........................	....	11.19	....	11.09	....	10.31	....	10.61
Total feed and pasture..........	....	90.68	....	98.86	....	117.08	....	130.33
Labor...........................	141 hr.	36.56	160 hr.	41.83	168 hr.	46.42	169 hr.	49.63
Other costs*....................	....	46.68	....	59.53	....	59.12	....	64.25
Total gross cost.................	....	173.92	....	200.22	....	222.62	....	244.21
Credits..........................	....	11.03	....	16.05	....	15.78	....	20.44
Net cost*.......................	....	162.89	....	184.17	....	206.84	....	223.77
Returns from milk†.............	....	141.22	....	177.72	....	219.10	....	260.73
Cost factors per 100 lb. milk:								
Concentrates....................	38.1	.76	28.9	.62	30.4	.67	32.0	.70
Succulent feed..................	136.8	.41	149.9	.42	112.7	.33	83.3	.24
Dry roughage....................	51.9	.34	42.3	.27	41.5	.30	40.4	.28
Pasture..........................	....	.21	....	.17	....	.13	....	.11
Total feed and pasture..........	....	1.72	....	1.48	....	1.43	....	1.33
Labor...........................	2.7 hr.	.69	2.4 hr.	.63	2.0 hr.	.56	1.7 hr.	.51
Other costs*....................	....	.88	....	.90	....	.72	....	.66
Gross cost......................	....	3.29	....	3.01	....	2.71	....	2.50
Credits..........................	....	.21	....	.24	....	.19	....	.21
Net cost*.......................	....	3.08	....	2.77	....	2.52	....	2.29

*Excluding milk hauling.
†Average price 1920-1924, $2.67 per cwt.

3,626 pounds of digestible carbohydrates and 442 pounds of digestible protein a year per cow, while in those herds producing more than 9,000 pounds the ration averaged 4,903 pounds of digestible carbohydrates and 697 pounds of digestible protein, a more liberal ration and one with a narrower nutritive ratio.

Labor expenditure per cow increased as production increased but not at as fast a rate. In the low-producing group 2.7 hours were spent for every hundred pounds of milk, and in the high-producing groups 1.7 hours. This was due to the fact that many of the operations in the care of the dairy herd take a fixed amount of time regardless of production. It does not take 100 percent more time to double the amount of grain or silage fed per cow, nor does it take as long to milk 15 cows giving 25 pounds apiece at a milking as it does to milk 25 cows averaging only 15 pounds each. The costs per cow other than feed and labor ran higher in the high-producing herds. One would expect that the better cows would receive better care, that they might be found on farms where the buildings are better and where overhead costs are higher, that the value of the cows would be higher and consequently that interest charges and taxes would be greater. Credits other than milk were also higher in this group. More manure was recovered from the liberally fed herds. Calves from high-producing dams naturally had a higher average value at birth.

The data on returns from milk indicate that, under conditions then prevailing, cows producing less than 7,500 pounds of milk per year were not returning their owners a very large wage for labor. With milk selling at $2.67 per hundred at the farm, the average cow in herds producing less than 6,000 pounds of milk failed by $21.67 of breaking even when all costs were charged against her, while those in herds producing more than 9,000 pounds made an annual profit over all costs, including labor, amounting to $36.96 per cow. Those farmers whose cows were in the low-producing class were realizing a return of less than 11 cents per hour of labor spent on the dairy enterprise, while those whose cows produced more than 9,000 pounds per year were receiving 51 cents per hour. Farmers should be as much interested in selling their labor to the best advantage as in getting good prices for their products. Selecting cows with a capacity for production and feeding them according to approved standards form the basis for successful dairying.

GROUND OATS AS A PARTIAL SUBSTITUTE FOR SHELLED CORN

Steers Fed at Madison County Experiment Farm

H. W. ROGERS AND PAUL GERLAUGH

Ground oats made a very satisfactory substitute for half of the shelled corn in a ration for fattening yearling steers during a feeding period of 140 days.

Ten pounds of shelled corn was fed daily to the corn fed lot of cattle. Five pounds of ground oats and five pounds of shelled corn made up the grain ration of the other lot of cattle

Shelled corn was valued at 91 cents per bushel and oats at 48 cents per bushel. To the price of oats 15 cents per cwt. was added for grinding. On this basis 100 pounds of shelled corn was worth \$1.625 and 100 pounds of ground oats \$1.65. Frequently ground oats are worth considerably less per pound than corn. When this is the case there is relatively more advantage in feeding ground oats than this test indicates.

Shelled corn produced more rapid gains on the cattle than did the combination of corn and oats. This increase in gains was not sufficient in 140 days to make a difference in selling price. Had the cattle been fed a month or so longer there probably would have been a difference in market value.

The bulkiness of the oats probably accounts for the slightly smaller amount of silage consumed by Lot 2.

Oats contain a larger amount of protein than does corn. Because of this, less linseed meal was added to the ration containing oats. The daily saving of 1.2 pounds of linseed meal, worth 3.1 cents, accounts for the lower cost of a hundred pounds of gain in the oats-fed lot of cattle.

Because of the lower cost of gains, 97 cents a hundred, the necessary selling price to break even, was 30 cents less in the oats fed cattle. This point together with a similar selling price per cwt. enabled the oats-fed cattle to return about three dollars more profit per steer, pork not considered.

More pork was produced in the lot fed shelled corn. Eight pigs in Lot 1 and five pigs in Lot 2 were given additional corn to keep them gaining well. Crediting the profit these pigs made to

the steers, we find the two lots of cattle even, so far as profitableness is concerned. Had the price of hogs remained the same there would have been less credit to the corn-fed lot of cattle.

When the returns per steer are figured on the basis of crediting feed saved by hogs back to the cattle there is still a slight margin in favor of the oat-fed lot, tho considerably less than existed before considering pork credits.

There is evidence from other tests that it pays well to grind oats for cattle even if the grinding materially reduces the amount of pork produced by pigs following cattle.

The test indicates that ground oats can profitably replace one-half the corn in a fattening ration for yearling steers when both corn and oats are valued the same per pound.

Because of the difference in yields a farmer wanting feed could not afford to seed oats in a field that is adapted to growing corn.

Feed your oats, it reduces the amount of protein concentrate needed. Combined with corn, oats produces satisfactory gains and financial returns as compared with corn alone.

Oats and Shelled Corn Compared with Shelled Corn for Yearling Steers

Madison County Experiment Farm

From December 13, 1927 to May 1, 1928 140 days	Lot 1 Shelled corn linseed meal mixed hay corn silage	Lot 2 Shelled corn ground oats linseed meal mixed hay corn silage
Number of steers per lot	11	11
Number of hogs following steers	8	5
Cost of steers at farm when test started	$10.75	$10.75
Average initial weight, pounds	733	730
Average final weight, pounds	1042	1026
Average daily gain, pounds	2.21	2.12
Average daily ration, pounds:		
Shelled corn	10	5
Ground oats	....	5
Linseed meal	2	.8
Mixed hay	2	2
Corn silage	34	32
Feed required per cwt. gain, pounds:		
Shelled corn	450	235
Ground oats	....	235
Linseed meal	89	38
Mixed hay	86	90
Corn silage	1553	1535
Cost of 100 pounds gain	$14.82	$13.87
Necessary selling price of cattle to break even (hogs not credited)	11.95	11.65
Actual selling price in lot May 1	12.50	12.50
Return per steer (pork not included)	5.65	8.71
Return per steer (including net increase in value of hogs)	12.16	12.17
Return per steer (crediting feed saved by hogs)	11.28	11.66

Feed prices: Shelled corn 91¢, oats 48¢ per bushel; grinding oats 15¢ per hundred pounds; silage $6, mixed hay $12, tankage $80, linseed meal $52, alfalfa leaf meal $40 per ton. Hogs valued at $8.50 at start and $10.50 at close of test.

OATS FOR GROWING AND FATTENING PIGS

W. L. ROBISON

Methods of utilizing oats to better advantage are greatly needed in regions where this crop is grown extensively. The average farm price of oats, on December 1, for the eight-year period, 1920 to 1927, was only 1.7 percent greater than it was for the eight-year period, 1908 to 1915, preceding the war; that of corn 17.3 percent greater. Notwithstanding their relatively lower price, large acreages of oats are still grown. During the eight-year period preceding the war 42.1 percent and during the last eight years 46 percent, as many bushels of oats as of corn were produced in Ohio.

Oats too bulky as only grain for pigs.—Because of the hulls they carry oats are too bulky or fibrous to produce rapid growth when used as the only grain for pigs. Altho the proportion varies widely, oats contain an average of approximately 30 percent of hull by weight, or 9.6 pounds of hulls and 22.4 pounds of kernels to the bushel.

The effect of oat hulls is shown by the results of an experiment in which they were added to a ration of hulled oats and tankage. The pigs fed hulled oats and tankage gained 1.25 pounds daily and ate 307.2 pounds of feed for each 100 pounds of gain. Similar pigs fed the same ration, except that it contained 22 percent of oat hulls, gained 1.03 pounds daily. They required 323.5 pounds of hulled oats and tankage and 91.9 pounds of oat hulls, or a total of 415.4 pounds of feed, for each 100 pounds of gain produced.

Table 1 summarizes the results of two experiments in which oats were fed to growing and fattening pigs in various ways. Oats contain approximately 12.4 and corn 9.4 percent of protein. Hence less supplement is needed with oats than with corn to provide rations having the same proportions of protein to carbohydrates and fats. The supplement consisted of tankage in one trial, and of tankage 2 parts and linseed meal 1 part in the other. To make sure that the vitamin and mineral needs were supplied, small quantities of ground alfalfa and minerals were included in the rations. There was doubtless a greater need for additional minerals with the rations consisting largely of grain than with those containing more tankage, which is relatively high in ash or mineral matter.

The pigs fed oats as a complete substitute for corn made slower and more costly gains than those fed corn. Their feed consumption per 100 pounds of gain was 26.8 percent greater than that of the corn-fed pigs. At the prices given in the table the amount of other feeds replaced by the ground oats made them worth 47 cents a bushel, or 85 percent as much as an equal weight of corn, for feeding as the only grain. This value does not take the slower gains of the oats-fed pigs into account. They required 31 days more time than those fed corn, to reach a market weight of 210 pounds.

TABLE 1.—Oats for Growing and Fattening Pigs

	Corn	Oats	Corn oats	Hulled oats
	Tankage, linseed meal,* ground alfalfa, minerals†			
Number of trials	2	2	2	2
Number of pigs	18	18	16	16
Initial weight per pig	51	51	50	51
Average daily gain	**1.10**	**.91**	**1.15**	**1.27**
Days required to gain 160 pounds	145	176	139	126
Daily feed per pig:				
Corn	3.62	....	2.86	....
Oats	....	4.18	1.16	3.49
Tankage	.40	.10	.34	.14
Linseed meal	.11	.03	.08	.03
Ground alfalfa	.13	.14	.14	.12
Minerals	.06	.07	.07	.06
Total	**4.32**	**4.52**	**4.65**	**3.84**
Feed per 100 pounds gain:				
Corn	327.48	....	248.55	....
Oats	....	459.49	100.94	274.08
Tankage	35.85	10.97	29.45	11.24
Linseed meal	10.18	3.09	6.80	2.51
Ground alfalfa	11.73	14.87	12.12	9.04
Minerals	5.87	7.44	6.06	4.52
Total	**391.11**	**495.86**	**403.92**	**301.39**
Cost of feed per 100 pounds gain‡	$7.70	$8.55	$7.67	$10.58

*Linseed meal was fed in only one of the trials.

†The minerals were salt 17.5, limestone 35, spent bone black 35, Glauber's salts 7.5, copperas 4.97, and potassium iodide .03 in one trial; salt 18.4, limestone 36.8, bone meal 36.8, Glauber's salts 5, copperas 2.97, potassium iodide .03 in the other.

All of the rations contained 1.5 percent of minerals and 3 percent of ground alfalfa. The corn, oats, and hulled oats were ground and the feeds mixed and self-fed in one trial and hand-fed in the other.

‡Prices were as follows: corn 91 cents and oats 48 cents a bu.; hulled oats $69.50, tankage $80, linseed meal $52, ground alfalfa $40 and minerals $40 a ton; grinding oats 15 cents and corn and hulled oats 10 cents a 100 lb.

Limited quantity of oats with corn beneficial.—As a partial substitute, oats have a higher value than as a complete substitute for corn. A limited quantity of oats along with corn produced more rapid gains than corn as the only grain. Altho the feed required for each 100 pounds of gain was somewhat greater, at the prices used in the table, the costs of the gains on the two rations were practically the same. In one experiment three times as much oats as tankage were fed, in the other twice as much oats as supplement.

The amounts given averaged approximately 1 part of oats to every 2.5 parts of corn, by weight. When fed in this way the ground oats were worth 97.3 percent per pound as much as the corn, or 53.7 cents a bushel as compared with corn at 91 cents a bushel.

Oats should be ground for pigs.—The benefit from grinding oats as compared with feeding them whole is apparently influenced by the ratio in which they are fed. Ground oats in the Illinois experiment referred to were worth 39 percent more than the whole oats when they were fed with the corn in the ratio of 2 to 1; 43 percent more when fed in the ratio of 3 to 1 and 57 percent more when fed in the ratio of 4 to 1. With whole oats at 48 cents these would amount to 18.6, 20.5, and 27.4 cents a bushel, respectively, in favor of the ground oats. A previous comparison of whole and ground oats when fed with corn in the 1:4 ratio gave similar results in favor of the ground oats.

Ground and whole oats, supplemented with tankage, linseed meal, alfalfa meal, and minerals, but fed as the only grains, were compared by Ferrin and McCarty at the Minnesota Station. The ground oats were worth only 1.4 cents a bushel more than the whole oats. In an experiment, somewhat similar, except that the pigs were on rape pasture, conducted by Evvard and his associates at the Iowa Station, grinding increased the value of the oats less than one cent a bushel. In another Iowa test, however, in which an average of 2.8 pounds of corn to 1 pound of whole oats and 2 pounds of corn to 1 pound of ground oats were consumed, the ground oats were worth nearly 35 percent more than the whole oats. With whole oats at 48 cents a bushel the ground oats would thus have a comparative value of 65 cents a bushel.

Possibly an explanation of the greater benefit from grinding oats when fed with corn, or from using them in the smaller proportions, is somewhat as follows: If the oats are finely ground the pigs do not separate the hulls and kernels. This necessitates the consumption of all of the hulls which is of little consequence as long as the oats do not constitute too large a proportion of the ration. On the other hand if whole or coarsely ground oats are fed the pigs separate a part of the hulls and kernels and spit out or leave some of the hulls. Because of its less-bulky character this increases the effectiveness of the feed actually eaten when large proportions of oats are fed, and thus tends to offset the benefit from grinding.

Soaking oats of little value.—Soaking both whole oats and ground oats and hand feeding them, as compared with self-feeding dry oats, at the Iowa Station failed to increase the gains from a given quantity of feed.

Hulled oats produce rapid gains.—Hulled oats make an exceptionally efficient grain feed for pigs. Table 1 includes a summary of the results of two experiments in which hulled oats, corn, oats, and a mixture of corn and oats were compared. The grain feeds were supplemented with tankage, ground alfalfa, and minerals in one trial, and with the same feeds and linseed meal in the other. All of the grains were ground. The pigs receiving hulled oats required 23 percent less feed for each 100 pounds of gain produced and reached a weight of 210 pounds almost three weeks earlier than those receiving corn.

As determined from the value of the feeds they replaced, ground hulled oats, as a complete substitute for corn, were worth 46 percent more a pound than the corn, or $50.45 a ton as compared with corn at 91 cents a bushel. Commercial hulled oats were used in the two experiments. They were too costly to be economical when fed as the only grain.

Hulled oats with corn economical.—In the second experiment hulled oats were fed to one lot in place of only a part of the corn. Two pounds of the hulled oats were allowed for each pound of the supplemental mixture. An average of one pound to every 2.3 pounds of corn was consumed. When fed in this way they were worth 62 percent more than an equal weight of corn, or $55.89 a ton, with other feeds at the prices given in the table.

Machines for hulling oats under farm conditions and others for commercial hulling are now on the market. Assuming that 95 percent of the oats are hulled and that the oats contain 30 percent of hull by weight, a bushel of standard weight oats would produce 21.28 pounds of kernels, 9.12 pounds of hulls and 1.6 pounds of light weight unhulled oats. With oats figured at 48 cents a bushel, hulling at 20 cents and grinding at 10 cents a 100 pounds, and with no allowance made for the hulls and light weight oats, the hulled oats would cost $53.20 a ton. Inasmuch as they were worth $55.89 a ton, with other feeds at the prices given, they would thus make a profitable feed for use in replacing a part of the corn. Whenever oats are relatively cheaper in price an even larger proportion of hulled oats could be used in the ration to advantage.

Hulled oats may be substituted for linseed meal.—Omitting the linseed meal from the trio supplemental mixture and feeding hulled oats in its place was tried in two experiments. Equal parts of hulled oats and tankage were fed in the first trial to its close and also in the second until the pigs reached an average weight of 100 pounds, after which 1½ times as much hulled oats as tankage was

used. In the first test (rather than feeding half as much alfalfa as tankage) the ground alfalfa was fed at the rate of 3 pounds in each 100 pounds of total feed. Table 2 gives a summary of the two experiments.

TABLE 2.—Hulled Oats as a Substitute for Linseed Meal in the Trio Supplemental Mixture

	Corn tankage linseed meal ground alfalfa minerals*	Corn tankage hulled oats ground alfalfa minerals*
Number of trials	2	2
Number of pigs	15	14
Initial weight per pig	52.5	52.8
Average daily gain	1.24	1.38
Days required to gain 160 pounds	129	116
Daily feed per pig:†		
Corn	3.97	3.95
Hulled oats	....	.44
Tankage	.356	.49
Linseed meal	.178	....
Ground alfalfa	.15	.18
Minerals	.07	.07
Total	4.72	5.13
Feed per 100 pounds gain:		
Corn	320.38	285.96
Oats	....	31.94
Tankage	28.76	35.55
Linseed meal	14.38	....
Ground alfalfa	12.17	12.74
Minerals	5.52	5.37
Total	381.21	371.56
Cost of feed per 100 pounds gain‡	$7.40	7.86

*The minerals were salt 17.5, limestone 35, spent bone black 35, Glauber's salts 17.5, copperas 4.97, and potassium iodide .03, in one trial; and of salt 19.4, limestone 77.6, and iron oxide 3 in the other.

†The rations in one trial contained 1½ percent of minerals, 3 percent of ground alfalfa, and equal parts of tankage and hulled oats, by weight; in the other 1.4 percent of minerals and hulled oats, tankage, and alfalfa in the ratio of 2:2:1 until an average weight of 120 pounds was reached after which the ratio was changed to 3:2:1. All of the feeds were mixed and self-fed.

‡Prices were as follows: corn 91 cents a bu.; hulled oats $69.50, tankage $80, linseed meal $52, ground alfalfa $40, and minerals $40 a ton; grinding 10 cents a 100 pounds.

The pigs getting hulled oats reached an average weight of 210 pounds 13 days before those getting linseed meal. The ration containing hulled oats also produced greater gains from a given amount of feed than the one containing linseed meal. Which would prove more economical would depend on the relative prices of corn and oats. At the prices used the feed cost per 100 pounds of gain was 40 cents greater for the hulled-oats ration than for the linseed-meal ration. With the hulled oats figured at $52.08 a ton there would be no difference in the cost of the gains. The faster gains and lower feed consumption per unit of gain of the hulled-oats pigs is a further indication of the high value of hulled oats for pigs.

NEW MODEL MASH FEEDER FOR LAYERS

D. C. KENNARD

Mash feeders like most everything else have to change to meet present requirements. Until the last few years the magazine type of feeder or hopper was the vogue. Then came the open box feeders which for obvious reasons have largely replaced the old magazine feeders or hoppers.

The reel mash feeder was designed at the Ohio Station in 1921 and has come into extensive use thruout the country. This feeder was 12 inches wide and 6 inches deep inside. Experience has proven it was too wide and too deep. It holds too much feed.

Feed fresh mash daily.—We found that for best results fresh mash should be fed daily in the evening in about the amount the birds will consume before the next feeding period regardless of the method of feeding. This requires a mash box of less capacity, hence the new model is reduced in width and depth so the last part of the feed in the bottom is easily accessible. With the advent of all-mash feeding the layers five years ago the question of suitable mash feeders and ample feeding space has come to be recognized as a matter of great importance. Even when grain and mash are fed separately the common error is to not provide suitable feeders with adequate feeding space.

Plenty of feeding space essential.—For each 100 leghorn layers 20 to 30 feet of feeding space should be provided, and for heavier breeds 30 to 40 feet. This applies equally to all-mash feeding or grain and mash, for if it is desired to feed grain separately, as many will, there is no better place to feed it than in the mash feeder on top of the dry mash. Surely in the light of present information the day is past when anyone should feel obliged to feed clean wholesome grain in filthy litter for sake of the traditional scratch grain-exercise theory. Furthermore this type of mash feeder makes the best and cleanest place to feed moist mash or germinated oats—simply put it right on top of the dry mash.

Suitable mash feeders and plenty of them are of first importance for profitable egg production. No one can afford to use obsolete feeding equipment. Just try one of these and see for yourself. At the same time try feeding a coarse granular mash daily as suggested and if it is your practice to feed scratch grain, moist mash, or germinated oats, try feeding it in this feeder on top of the dry mash and see whether you will again care to throw clean wholesome grain in filthy, dusty, or damp litter.

NEW MODEL REEL MASH FEEDER FOR LAYERS

The photograph shows general plan of construction. The box is 4 inches deep 8 inches wide and the length according to the number of birds to be accommodated. This feeder is 12 feet long and is designed to serve 100 leghorns. The two 2 by 2 inch square revolving poles are 6 feet long and are used instead of one 12 feet long to prevent sagging. The pole supports are made of No. 7 hard steel wire. Plaster lath are nailed on top edges of box and extend

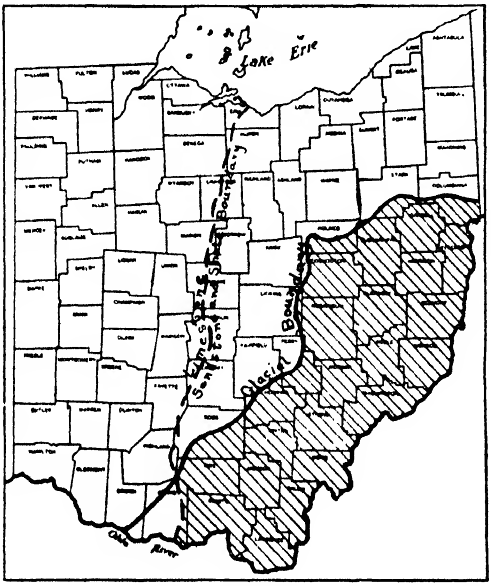
New model reel mash feeder for layers

inside ¾ inch to prevent waste of feed. The clearance between poles and edges of box is 3½ inches for leghorns and 4½ inches for heavier breeds. The stand supports mash box 18 inches off the floor. The 1 by 3 inch boards for birds to stand on while eating are even with the bottom of the box and spaced 1½ inches from the box.

THE RESIDUAL SANDSTONE AND SHALE SOILS OF OHIO

G. W. CONREY

The areas of residual soils* in Ohio are in the southern and southeastern parts of the State, a region of rolling, hilly topography. This region is part of the Appalachian Plateau. It is bordered on the north by the glacial area, the southern boundary of which extends from Columbiana County west into Holmes County, and thence southwest thru Chillicothe to the Ohio River.



Area of residual sandstone and shale soils

Origin of the soils.—The upland soils are for the most part residual in origin, that is, they have been formed by the weathering in place of the bed rock of the region. Because of the rolling surface of much of the land, erosion has been active and has prevented the accumulation to any great depths of the soil formed. It is evident, then, that the character of the soil will be closely related to the kind of rock from which it was derived.

In southeastern Ohio the predominating rocks are noncalcareous sandstones and shales of the Mississippi and Pennsylvania (the Coal Measures) age. Limestone, coal, and fire clay make up a relatively small percentage of the rocks, altho they are of great economic importance. Much of the sandstone is very fine grained and weathers to a silt loam; a part is coarse grained, and weathers to loams and sandy loams. The shales are also variable in nature, weathering to silt loams, silty clay loams, and clays. A red clay shale has given a heavy plastic red clay.

*The residual limestone soils of Adams and adjoining counties will not be discussed in this paper.

Limestone is of minor importance over much of the area, but is in sufficient amounts locally to give some areas of residual limestone soil. In the Mississippian formations, which occur in the western part of the region, there is practically no limestone, except in a very few locations. The lower Pennsylvanian formations contain thin beds of limestone (2 to 6 feet thick) which commonly are associated with beds of coal and fireclay, but these are too limited to influence the soil except locally. The formations in the southeastern part of the region contain a much larger percentage of limestone, so that in places residual limestone soils (blue grass soils) are common.

Altho many of the beds of rock can be traced over a wide area, vertically the rocks are quite variable, for example, almost every exposure of rock will show a succession of beds of sandstone and of shale. The beds of limestone, coal, or fire clay are seldom over a few feet thick. This has resulted in the soil's being derived in the most part from mixed sandstone and shale, or mixed sandstone, shale, and limestone.

It is sometimes thought that soils in a hilly section are old soils. However, the expression "as old as the hills" does not apply to the soil; rather the soils are young soils, for erosion is continually active in removing the soil from the sloping lands, and new soil is being formed by the weathering of the rocks.

Topography and drainage.—The topography of the region is rolling and hilly. Streams and their valleys penetrate to all parts of the region, so narrow ridges, steep valley sides, and level valley floors of variable width are characteristic. Adjacent to the Ohio River and other major streams many of the slopes are very steep and precipitous. In such a region drainage is a problem only on some of the broader ridge tops, or on bottom or terrace lands.

The utilization of the land is closely related to its topography or slope, because of the possibility of serious damage by erosion. On gently rolling areas and broad ridge tops agricultural practices similar to those of the level portions of the State can be followed, in that intertilled crops can be grown and all kinds of farm machinery can be used. On the hill sides the frequent growth of intertilled crops may result in serious damage by erosion. Other areas are so steep as to be adapted only for permanent pasture or for forestry.

SOILS OF THE RESIDUAL SANDSTONE AND SHALE REGION

A. UPLAND SOILS (Residual Soils)

The upland soils of southeastern Ohio are of residual origin; their differences in characteristics are closely related to the type of rock from which they have been derived. Only on the broad upland flats or ridge tops has imperfect drainage tended to modify the soil as a result of imperfect aeration. Based on differences in color and character of the soil material, the soils have been grouped into a number of series.

Muskingum series*.—The Muskingum series includes soils with a grayish brown or yellowish brown surface, and yellow subsoils. Within 18 to 30 inches are partially weathered sandstone and shale. Fragments of these rocks are common thruout the soil. Being derived from noncalcareous formations, the Muskingum soils invariably are acid. These soils occupy rolling to very rolling areas. Muskingum silt loam and loam are important types and are the most extensive soils of southeastern Ohio. The smooth phase occurs on broad ridge tops, the steep phase on the steeper slopes. The steep phase is adapted only for permanent pasture or forestry. Muskingum silt loam is one of the soils on the Belmont County Experiment Farm, and on the Southeast Test Farm near Carpenter in Meigs County.

Tilsit series.—These soils have grayish brown to brown surface soils and pale yellowish brown upper subsoils. Below 14-20 inches the subsoil is mottled yellowish brown, gray, and rust brown. The depth to the partially weathered bed rock is greater than that of the Muksingum soils, altho the Tilsit soils are derived from the same type of rocks. The topography is gently undulating. The surface drainage is fair to good but the underdrainage is only fair to poor. This soil is closely associated with the Muskingum, but occupies the broad ridge tops where drainage conditions have resulted in an imperfectly oxidized subsoil. Tilsit silt loam is the chief type. Because of its favorable topography it is an important soil agriculturally, altho rather limited in extent.

Upshur series.—The Upshur soils have dark reddish brown to reddish brown surface soils and red subsoils. They are derived from red, green, and yellow shales and clay shales. Like that of the Muskingum soils the depth to the parent rock is rather shallow.

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*In former soil reports the Muskingum series has been called the Dekalb series. The Dekalb series now includes a podsolized (gray) soil in the high plateau in Pennsylvania and West Virginia, a soil which does not occur in Ohio.

TABLE 1.—Soils of the Residual Sandstone and Shale Region

Upland soils (residual)

Color of soil	Yellowish brown	Grayish brown	Reddish brown	Brown	Mixed	Mixed	Mixed Upshur,	Light brown
Color and	Yellow	Mottled yellowish brown and gray	Red	Upper subsoil Yellowish brown	Muskingum and	Muskingum and	Brooke, and	Upper subsoil brown
Character of subsoil	Sandstone and shale at 18–30 inches	Sandstone and shale at 24–36 inches	Red, green, or yellow clay shale at 20–30 inches	Lower subsoil yellow-olive Limestone at 24–36 inches	Upshur soils	Boooke soils	Muskingum soils	Lower subsoil yellowish-brown free of rock fragments to 36 inches or more
Topography	Rolling to very rolling	Gently rolling	Rolling to very rolling	Rolling to very rolling	Rolling to very rolling	Rolling to very rolling	Rolling to very rolling	Undulating to slightly rolling
Natural drainage	Good	Fair	Good	Good	Good	Good	Good	Good
Series	**Muskingum**	**Tilsit**	**Upshur**	**Brooke**	**Meigs**	**Westmoreland**	**Belmont**	**Zanesville**
Important textures	silt loam loam	silt loam	clay	silty clay loam	silty clay loam	silty clay loam	silty clay loam	silt loam

Terrace soils (second bottom)

Color of soil	Brown	Brown	Grayish brown	Gray	Brown	Light brown	Gray	Brown
Color and	Brown with reddish cast	Yellowish brown	Mottled yellowish brown and gray	Mottled gray, yellowish brown and rust-brown	Yellowish brown	Mottled yellowish brown and gray	Mottled yellowish brown and rust-brown	Upper subsoil yellow to reddish yellow
Character of subsoil	Stratified sand gravel at 3–8 feet	Lower subsoil heavy (silt and clay) (Reaction acid)	Lower subsoil heavy (silt and clay)	Lower subsoil heavy (silt and clay)	Lower subsoil heavy (silt and clay) (Reaction neutral)	Lower subsoil heavy (silt and clay)	Lower subsoil heavy (silt and clay)	Lower subsoil red to dark red laminated clay
Associated upland soil		Muskingum	Muskingum	Muskingum	Westmoreland	Westmoreland	Westmoreland	Upshur
Topography	Level	Level	Level	Level	Level	Level	Level	Level
Natural drainage	Good	Good	Fair	Poor	Good	Fair	Poor	Good
Series	**Wheeling**	**Holston**	**Monongahela**	**Tyler**	**Elk**	**Captina**	**Robertsville**	**Vincent**
Important textures	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam	silt loam

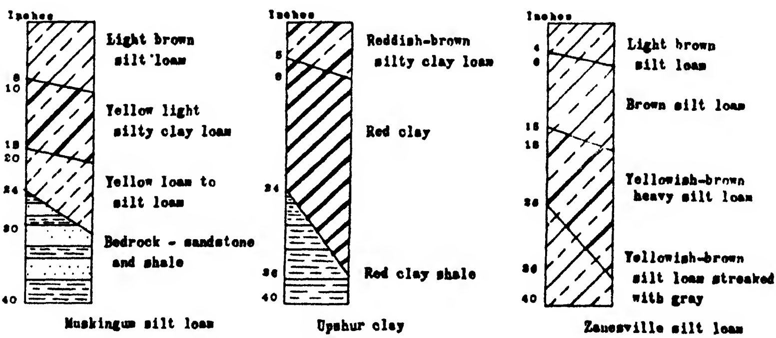
TABLE 1.—Soils of the Residual Sandstone and Shale Region—Continued

Flood plain soils (first bottom)							
Color of soil	Brown	Grayish brown	Gray	Dark brown	Grayish brown	Gray	Reddish brown
Color and	Yellowish brown	Mottled yellowish brown and gray	Mottled gray, yellowish brown and rust-brown	Brown	Mottled yellowish brown and gray	Mottled gray, yellowish brown and rust-brown	Brownish red
Character of subsoil	(Acid in reaction)			(Neutral in reaction)			
Associated upland soils	Muskingum	Muskingum	Muskingum	Westmoreland	Westmoreland	Westmoreland	Upshur
Topography	Level	Level	Level	Level	Level	Level	Level
Natural drainage	Good	Fair	Very poor	Good	Fair	Very poor	Good
Series	**Pope**	**Philo**	**Atkins**	**Huntington**	**Linside**	**Holly**	**Moshannon**
Important textures	loam silt loam	silt loam	silt loam silty clay loam	silt loam	silt loam	silt loam silty clay loam	silt loam

These soils are neutral to slightly acid. They occupy rolling to steep lands. Upshur clay is the most important type. This soil occurs on the Washington County Experiment Farm, also on the Southeast Test Farm.

Brooke series.—This series includes soils with brown surface soil and yellowish brown upper subsoil; and yellow olive, rather heavy lower subsoils. Bedrock-limestone is encountered at less than 3 feet below the surface and there are fragments of it on the surface and thruout the soil. This soil is derived from the limestone beds associated with the other rocks of the region. It is only where the limestone is near a ridge top that this soil is developed. The soils are neutral or alkaline in reaction. Brooke silty clay loam is the chief type. This soil supports an excellent growth of blue grass, and is well adapted to clovers and alfalfa.

Meigs series.—The Meigs series is a mixed series. It includes yellowish brown soils derived from materials similar to those which give rise to the Muskingum soils, but having bands of red and greenish shales interbedded with the sandstone and shale. The result is a mixture of Muskingum and Upshur soils. On ridge tops a yellowish surface soil may overlay a red clay subsoil. The topography thruout much of the area of Meigs soils is very rolling. Meigs silty clay loam is the important type. This soil occurs on the Southeast Test Farm and on the Washington County Experiment Farm.



Westmoreland series.—This also is a mixed series. It differs from the Muskingum principally in that it is influenced to some extent by limestone and calcareous shales, and typically has a somewhat heavier subsoil. As mapped by the Soil Survey it includes areas of Muskingum and Brooke soils. Because they are less acid naturally than the typical Muskingum soils, much of the West-

moreland soils support a blue grass vegetation, which furnishes excellent pasture. Westmoreland silty clay loam is the important type. This soil occurs on the Belmont County Experiment Farm.

Belmont series.—The Belmont series includes areas of red soils (Upshur) affected to a noticeable extent by limestone. It may be regarded as a mixture of red soils (Upshur), limestone soils (Brooke), and sandstone and shale soils (Muskingum). It occupies rolling areas. Belmont silty clay loam is the chief type.

Zanesville series.—This series includes soils of a very silty nature with grayish brown to light brown surface soil; a light brown subsurface; a brown upper subsoil, somewhat heavier than the horizons above; and a lower subsoil that is brown, somewhat streaked with gray. The depth to bed rock is usually more than 40 inches and to a depth of 36 inches or more the soil is free from gravel, stone fragments, or other coarse material. The underlying material is variable, in places being partially weathered sandstone, elsewhere beds of fine and very fine sand. The fine sand deposits are used for molding-sand in the vicinity of Zanesville. These soils have definite layers or horizons of varying characteristics which show that it is a mature soil.

The exact origin of these soils is in question. The soil material may be in part residual, in part water laid, and in part deposited by wind action. They occupy undulating to almost level areas on ridges or on high benches. Zanesville silt loam is the most important type.

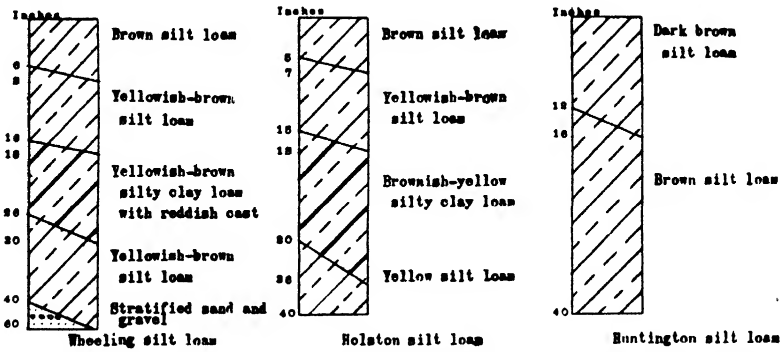
B. TERRACE SOILS

Associated with the upland soils are the various terrace or second bottom soils. These are in the valleys of present or former streams and are commonly spoken of as "second bottom lands". They are not subject to overflow, except in extremely high floods. Two groups have been recognized. The first is characterized by layers in the lower subsoil of stratified sand and gravel which were deposited by streams coming from the melting ice that existed in the region to the north during the glacial period. These soils have been included in the Wheeling series.

The second group includes old-stream or alluvial deposits that were left as terraces or second bottoms as a result of the downward cutting action of more recent streams. The lower subsoils consist chiefly of silt and clay rather than sand and gravel. Where the deposits have been formed by wash from areas of Muskingum soils (soils with acid reaction) the associated terraces are included in the Holston, Monongahela and Tyler series. Where the terrace soils

are derived from limestone wash chiefly (areas of Westmoreland and Brooke soils) they are included in the Elk, Captina, and Robertsville series. Where the terrace soils are red in color, derived from the wash from Upshur soils, they are included in the Vincent series. Because of the favorable topography, the terrace soils are of considerable importance agriculturally.

Wheeling series.—The Wheeling soils have a brown to dark brown surface soil. The upper subsoil is somewhat heavier than the surface and breaks up into brown pieces which have rather distinct reddish-brown coatings, altho the mass when mixed up has a brown to yellowish brown color. The lower subsoil is yellowish brown. In the heavy members of the series, such as the silt loam, the lower subsoil consists of silt and very fine sand to 5 or 6 feet, underlain by stratified sand and gravel. In the sandy types the depth to gravel is less. These soils are slightly acid. The topography is level and the drainage good. Wheeling silt loam is the most extensive type. It has its best development on the high terrace along the Ohio River.



Holston series.—The surface soils of this series are brown to light brown and the subsoil yellowish brown, free from mottlings to 30 inches or more. The soil usually shows a distinctly heavy horizon from about 16 to 24 inches. The lower subsoil consists of stratified silt, clay, and very fine sand, with an occasional gravel bed; for the most part the lower subsoils are heavy in texture to considerable depth. These soils have been formed by wash from the adjoining uplands in areas where Muskingum soils predominate. They are acid in reaction. They occupy level terraces and have good drainage. Holston silt loam and loam are important types.

Monongahela series.—This series includes soils with a grayish brown to light brown surface soil, pale yellowish brown subsurface, and mottled subsoils. The lower subsoil consists of silt and clay.

These soils along with the Holston and Tyler, which are of similar origin, are widely distributed over southeastern Ohio, where they exist as high bottom or terraces in the valleys of the region. The Monongahela soils have a level topography. The underdrainage is only fair. Monongahela silt loam is the chief type.

Tyler series.—The Tyler series includes soils with a gray surface soil, and mottled gray and yellowish brown subsoils. They occupy low lying areas or depressions in terraces in association with the Monongahela and Holston soils. The topography is level and the natural drainage is very poor. Tyler silt loam and silty clay loam are important types.

Elk series.—The Elk soils are characterized by brown to dark brown surface soils and yellowish brown subsoils. They occur on the high bottoms or terraces along streams which drain uplands containing considerable limestone (Westmoreland and Brooke soils). These soils are commonly neutral in reaction. The topography is level and the natural drainage good. Elk silt loam is the chief type.

Captina series.—These soils are light brown in the surface, pale yellowish brown in the subsurface, and mottled in the subsoil. They are similar in origin and location to the Elk, but are not so well drained naturally. The silt loam is the chief type.

Robertsville series.—The Robertsville series includes soils with a gray surface, and mottled gray and yellowish brown subsoils. They are associated with the Elk and Captina soils on terraces or second bottoms. The topography is level and the drainage very poor. Robertsville silt loam is the chief soil type.

Vincent series.—The surface soil of the Vincent series is brown, underlain by yellowish brown subsurface. This grades thru a yellow tc reddish yellow into red subsoil which consists of a calcareous red to dark red laminated clay. The reddish substratum occurs at depths varying from 20 to 40 inches. It occurs on terraces in old valleys in regions where the red Upshur clay is an important soil. The topography is level to undulating and the natural drainage very good. Vincent silt loam is the important type.

C. FLOOD PLAIN SOILS

These soils include the first bottom lands, which are subject to annual overflow. They have been deposited by the present streams, and are made up of the wash from the surrounding uplands. Where sandstone and shale predominate (Muskingum soils) the flood-plain soils are included in the Pope, Philo, and Atkins series.

These soils are acid in reaction. Where considerable limestone is associated with the sandstone and shale (Westmoreland and Brooke soils) the well-drained flood-plain soils are neutral in reaction. These have been included in the Huntington series, and the associated series are Linside and Holly. The red flood plain soils (wash from Upshur clay) are classified in the Moshannon series.

Pope series.—The Pope series includes the brown well-drained bottom soils along streams which receive most of their drainage from sandstone and shale uplands (Muskingum soils). They are typically acid in reaction. The chief types are Pope and silt loam.

Philo series.—This series includes soils with light brown to grayish brown surface soils and mottled brown and gray subsoils. They are similar in origin to the Pope soils, but are not so well drained. Being subject to annual flooding they are used chiefly for corn or permanent pasture. Philo silt loam is the chief type.

Atkins series.—Atkins soils have gray to dark gray surface soils and mottled gray and yellowish brown subsoils. They include the very poorly drained areas in the flood plains in association with the Pope and Philo soils. Atkins silt loam is the principal type.

Huntington series.—The Huntington series includes the well-drained brown to dark brown flood plain soils along streams receiving a large part of their waters from uplands containing some limestone soils (Westmoreland soils). The Huntington soils are generally neutral or only slightly acid. These are very fertile bottom soils and are used largely for corn production. Huntington silt loam and loam are important types.

Linside series.—The surface soils of this series are grayish brown to light brown and subsoils are somewhat mottled in color. They are associated in flood plains with Huntington soils, but are not so well drained naturally. Linside silt loam is the chief type.

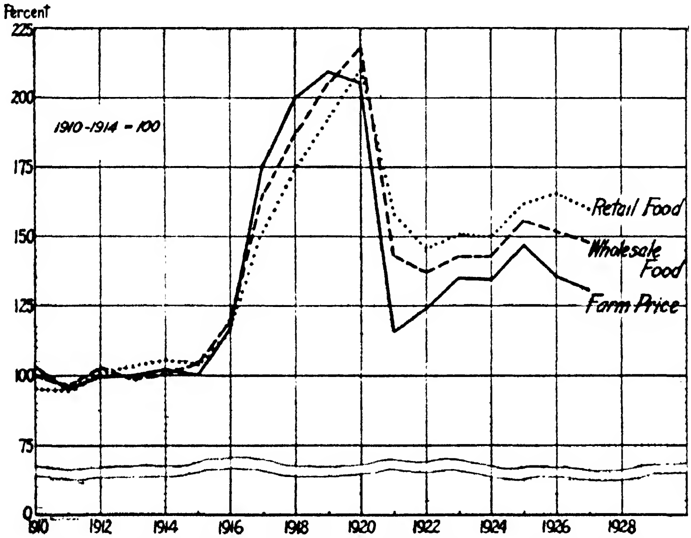
Holly series.—This series includes alluvial soils with gray surface and mottled gray, yellowish brown and rust brown subsoils. They occur in flood plains in association with Huntington and Linside soils, and are similar in origin. The topography is level and the drainage very poor. These soils are subject to annual overflow. Because of these unfavorable conditions the Holly soils are used chiefly for permanent pasture. Holly silt loam and silty clay loam are the chief types.

Moshannon series.—The Moshannon series includes soils with a reddish brown surface and brownish red subsoils. These soils occur along streams in regions where principal upland soils are of Meigs, Upshur, and Belmont series. The topography is level and the natural drainage good. Moshannon silt loam is the chief type.

FARM, WHOLESALE, AND RETAIL FOOD PRICES

J. I. FALCONER

The accompanying chart shows the course of the price level of farm products at the farm, the price of food products in the wholesale market, and the retail price of food products The prices are for the United States, the years 1910 to 1914 have been selected as a base of 100, and the prices of other years compared with these years. It will be noted that up to 1916 the price levels were fairly close, that in 1917, 1918, and 1919 the farm price ranged above the wholesale and retail price level. There were years of profitable



Retail and wholesale food: Bureau of Labor Statistics index numbers converted to 1910-1914 base.
Farm Price: Bureau of Agricultural Economics, U. S. Department Agriculture index.

agriculture. Since, 1920, however, the farm price level has, been far below that of the wholesale or retail price level. Various reasons have been assigned for this spread, chief among which are higher wages and higher transportation rates. Transportation charges on Ohio farm products are 90 percent higher than in 1915, while city wages are at least twice that of pre war. Thru the period of adjustment to new price levels it seems that retail and wholesale prices have maintained a higher level than the prices received by farmers for their products.

INDEX NUMBER OF PRODUCTION, WAGES, AND PRICES

J. I. FALCONER

In this issue there is included in the table for the first time a column showing the gross cash income received by Ohio farms from the sale of farm products.

The column headed "Ohio Farm products prices" shows monthly and annually the fluctuation in the prices received by Ohio farmers for the products which they sell. This index is a measure of price changes but it does not take into account variation in the quantity sold. The new index under "Ohio Cash Income from Sales" is the product of quantity sold times price. It is therefore a measure of the total cash income. The latter index is constructed with the average monthly income for 1924, 1925, and 1926 as a base of 100. The two index figures are not directly comparable.

Trend of Prices and Wages, 1910-1914=100

	Wholesale prices all commodities	Weekly earnings N. Y. state factory workers	Non-agricultural products U. S.	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales*
2913	102	....	105	100	104	100	104	....
1914	100	100	97	102	102	102	105	....
1915	103	101	101	100	103	107	106	....
1916	130	114	138	117	113	113	121	....
1917	181	129	182	176	140	119	182	....
1918	198	160	188	200	175	131	203	....
1919	210	185	299	209	204	135	218	....
1920	230	122	141	205	236	159	212	154
1921	150	203	167	116	164	134	132	90
1922	152	197	168	124	145	124	127	88
1923	156	214	171	135	166	122	134	95
1924	152	218	162	134	165	118	133	95
1925	161	223	165	146	165	110	159	98
1926	154	229	161	136	170	105	155	108
1927	149	231	152	131	173	99	147	94
1927								
January	150	232	156	126	172	....	145	102
February	149	231	155	127	....	....	145	97
March	148	234	153	126	....	99	144	93
April	147	230	151	125	172	....	144	91
May	147	230	150	126	....	....	145	97
June	146	230	150	130	....	....	147	100
July	147	228	151	130	174	....	147	103
August	149	231	151	132	....	....	149	99
September	152	233	152	140	....	....	149	83
October	152	231	151	139	175	....	150	88
November	152	226	151	137	....	....	149	88
December	152	233	151	137	....	....	145	90
1928								
January	151	230	151	137	158	....	141	96
February	151	230	152	135	....	....	141	87
March	151	233	....	137	....	98	146	87
April	153	227	....	140	172	....	152	85
May	....	....	....	148	....	....	167	98

*Average month 1924, 1925, and 1926=100.

The new index shows that, while the prices received have been much higher during the first half of 1928 than of 1927, the total income has been less due to having less products to sell.

The Bimonthly Bulletin

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Ohio Agricultural Experiment Station

CONTENTS

OHIO AGRICULTURAL EXPERIMENT STATION

Wooster, Ohio, U. S. A.

NEW MONOGRAPH BULLETINS

No. 411, Varieties of Apples in Ohio, II, C. W. Ellenwood, supplements Bulletin 290, describing 155 varieties grown in the Station orchards but not previously described in Station publications. The author comments on their origin, uses, and value.

No. 412, The Rural Health Facilities of Ross County, Ohio, C. E. Lively and P. B. Beck, is based on data obtained by a survey of four typical rural districts of 50 families each. The authors discuss the health agencies, the use made of existing facilities by rural people, and factors of variability in the use of these facilities.

No. 413, Spraying for Prevention of Apple Blotch and Apple Scab, F. H. Ballou and I. P. Lewis, gives the results of a five-year spraying experiment in which standard and dilute bordeaux mixtures and lime-sulfur solutions were compared in the control of these diseases.

No. 414, Canada Thistle, *Cirsium arvense* Tourn., Field Thistle, Creeping Thistle, Freda Detmers, describes the many strains or variations of the weed, its introduction and spread, propagation, natural enemies, and methods of eradication.

No. 415, The Influence of Fertilizers on the Vitamin-B Content of Wheat, C. H. Hunt, gives the results of experiments to determine the relation of the mineral content of wheat and its Vitamin-B content, by feeding to white rats wheat in varying amounts from selected plots in the 5-year rotation fertility experiment.

No. 416, Economic Aspects of Ohio Farmers' Elevators, L. G. Foster. In this 77-page bulletin the author traces the development of farmers' elevators in Ohio, discusses the cost of operation, buying and selling practices, grading and storing grain, hedging, the handling of merchandise and livestock, and accounting practices.

No. 417, The Forty-sixth Annual Report, C. G. Williams. This progress report of the Director for 1926-27 gives some of the important findings or results of the experimental and research work of the ten departments of the Station. It was mailed to a list of about 5,000, including libraries, agricultural institutions and workers. It is being mailed to others on request.

No. 418, The Apple Industry of Ohio, Chas. W. Hauck. The bulletin contains a mass of data on the apple industry of Ohio and the United States. The author discusses production, varieties grown, storage, distribution, and prices.

No. 419, Livestock Production Costs in Greene County, Ohio, John F. Dowler. Cost-of-production records from a group of farms furnished data for this study and comparison of practices in livestock production. The cost of producing hogs, cattle, sheep, and poultry and their products and the returns on the different farms are discussed and compared.

Continued on page 231

THE EFFECT OF THE COW'S RATION ON THE FOOD VALUE OF MILK

W. E. KRAUSS

It is no longer possible, in the light of our newer knowledge of nutrition, to express the complete value of any food in terms of a particular unit, such as the calorie. In addition to the digestibility and energy value of a food, the quality of the protein and the mineral and vitamin content all exert an influence, and probably are dependent on each other in maintenance, growth, production, and reproduction.

The first and most important food in the early life of all mammals is milk. Its importance in the diet of children beyond the baby stage has been recognized in recent years more than ever before, with the result that all over the country public health authorities are preaching the gospel of more and better milk. Of the great number of foods known to man, milk comes nearest to furnishing a complete diet in itself. No more fitting problem, therefore, presents itself than that of determining the conditions under which the best milk, from the standpoint of public health, can be produced.

For a long time milk was milk regardless of its source or the method of production and subsequent handling. Gradually certain precautions were taken, until today there is quite an elaborate system of grading milk according to its fat and bacteria contents and the method of production and subsequent handling. As yet no attempt has been made to grade milk according to its total food value, because of the difficulties involved in determining this factor. It is recognized, however, that the way in which cows are fed influences to some extent the food value of milk. A study of the effect of various rations on the nutritive properties of milk, therefore, should determine the kind of rations or specific feeds that are desirable or undesirable.

By "food value" is meant the ability of a food to furnish the various nutrients and accessory substances required to permit the normal functions of the animal, such as growth, production, and reproduction. A complete diet, as we understand it, must contain adequate amounts of the following substances:

1. Energy producing substances
2. Protein of good quality
3. Minerals—Calcium, phosphorus, iron, etc.
4. Vitamins

Milk is a good source of energy, the energy-giving constituents being the fat and lactose (milk sugar). The chief proteins of milk, casein and lactalbumin, are of good quality, that is, they furnish the necessary material (amino acids) required for building up the body.

As a source of calcium, milk is in a class by itself. It is the best natural source of this important mineral. Phosphorus, the other mineral which plays such a big part in the formation of bones and teeth, is also well supplied by milk. Iron, another very important mineral, is present in milk in but very small quantity and is a limiting factor when the diet consists of nothing but milk.

The vitamins are all present in milk to a greater or less extent. (Vitamin A stimulates growth and general health; it reduces the susceptibility to certain infectious diseases, particularly of the eyes. Vitamin B promotes growth, stimulates the appetite, and maintains the normal functions of the digestive organs. Vitamin C prevents the disease known as scurvy from developing. Vitamin D aids in the assimilation of the minerals that go into the bones and teeth. Vitamin E is related to reproduction.)

Since energy, protein, and minerals are derived from chemical constituents of milk, the first question to be considered is the effect of the cow's ration on the chemical composition of milk. This phase of the problem can be dismissed rather briefly. A review of the vast amount of work that has been done on this shows that the chemical composition of milk is very constant, even when severe changes in the type of ration are made. The fat is the most variable constituent, but it is practically impossible to bring about a permanent change in the percentage of fat by feeding. Many feeds of high fat content have been tried with this object in view, but, after adjustment to the ration, the increase in fat content apparent at the beginning soon disappears and the original percentage is restored. Large doses of cod-liver oil (8 oz. per day) actually diminish the fat content. Recent work has also shown that temperature and other environment factors affect the fat content of milk even when there is no change in feed.

The three most important minerals in milk—calcium, phosphorus, and iron—are but slightly influenced by changes in the feed. There is some evidence that the amount of phosphorus increases slightly with an increased phosphorus intake. While

sunlight, or ultra-violet light, cannot be classed as feed, some recent work has shown that exposure of the cow to ultra-violet light for one hour a day slightly increased the amount of calcium in milk. The relation between iron in the feed and iron in the milk offers much room for exploration. The evidence to date indicates that an increased iron intake does not increase the amount of iron in the milk.

Research work indicates that in general when a cow's ration lacks some of the necessary nutrients for milk formation there will be a decrease in milk flow rather than a change in the chemical composition of the milk. Also, any excess of these same nutrients will be excreted thru paths other than the mammary glands.

With regard to the vitamin content of milk, however, the situation is different. The evidence concerning the influence of the cow's ration on the vitamin content of milk is quite contradictory, but in general it may be said that the potency of milk in all the vitamins is more or less influenced by the nature of the ration.

There is no question about the influence of the feed on the vitamin-A content of milk. As the amount of vitamin A in the feed increases, the amount of this vitamin in the milk increases. The most practical way to increase vitamin A is thru the use of well-cured, leafy roughage, such as clover or alfalfa hay, or pasture. Summer milk is more potent in this factor than is winter milk.

It has been shown recently that cows do not require vitamin B in their feed. They can synthesize this vitamin thru bacterial action in the paunch and put it into the milk even tho none be present in the feed. This does not mean, however, that the extent of this bacterial synthesis may not be influenced by the nature of the feed.

There is conflicting evidence regarding the effect of feed on the vitamin-C content of milk. Most of the experimental work has shown that as the vitamin-C content of the feed (usually pasture grass or green feed of some sort) is increased the vitamin-C content of the milk is increased. Feeding a high grade of silage the year round has been found to maintain the vitamin-C content of milk at a fairly constant level. At best, vitamin C is easily destroyed by exposure and heat, so that milk, particularly when pasteurized, cannot be relied upon to furnish this factor.

European work with vitamin D indicates that exposure of the cow to sunlight or ultra-violet light exerts more influence on the vitamin-D content of her milk than does the feed. In this country no appreciable improvement in the vitamin-D content of milk has

been observed from such treatment. This is attributed to the inability of the rays to penetrate the hide. Milk at best is a rather poor source of this vitamin.

Feeding experts can decide quite accurately on the combination of feeds, under the particular conditions involved, that will result in maximum milk production. To go beyond that and be able to recommend the combination of feed that will produce the best quality of milk, in terms of food value, would be highly desirable. The best recommendation that can be made at the present time is to feed a good grain mixture with some form of well-cured leafy roughage and silage, in the winter, and with pasture in the summer.

THE EFFECT OF THE COW'S RATION ON THE VITAMIN-A AND VITAMIN-B CONTENT OF MILK

W. E. KRAUSS

As one of the steps in the study of the effect of the cow's ration on the food value of milk, determinations of the vitamin A and vitamin B content of milk from cows fed widely different rations

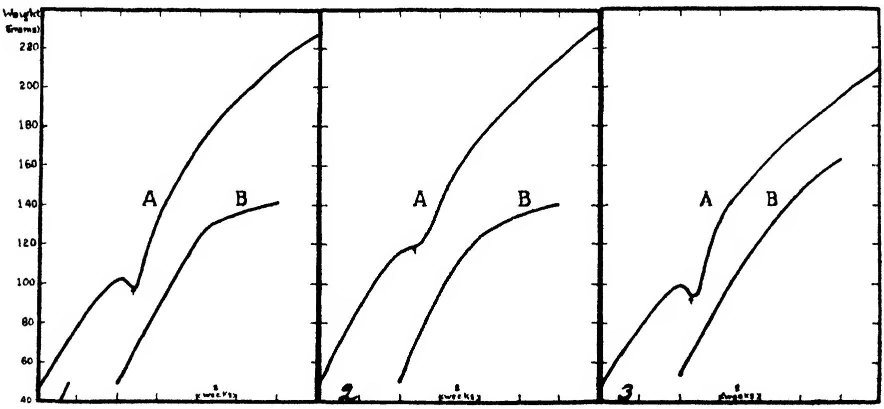
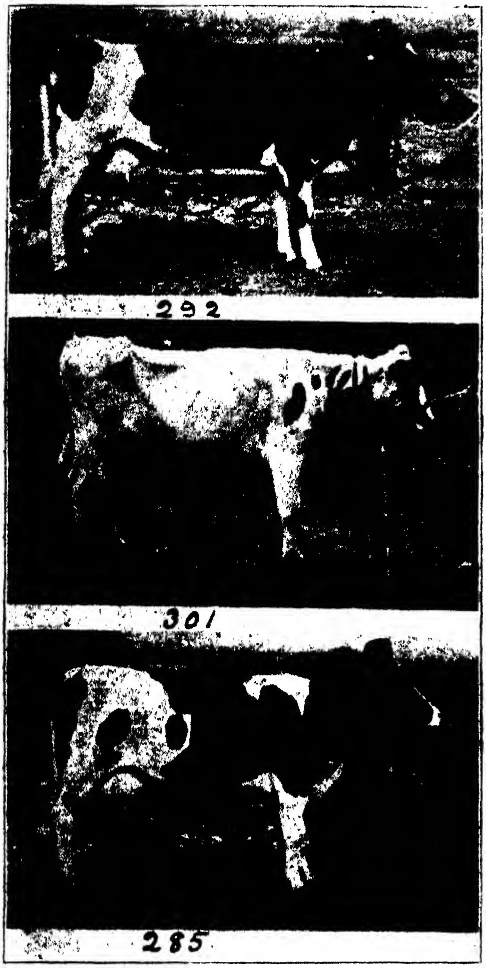


Fig. 1.—Growth curve of rats in testing vitamin content of milk

1. A—Rats receiving a basal ration lacking in vitamin A, plus 8 cc. of milk from high protein cows (milk added at bend in curve).
   B—Growth curve when 15 cc. of milk supplemented a basal ration lacking in vitamin B.
2. A—Rats receiving a basal ration lacking in vitamin A, plus 8 cc. of milk from low protein cows (milk added at bend in curve).
   B—Growth curve when 15 cc. of milk supplemented a basal ration lacking in vitamin B.
3. A—Rats receiving a basal ration lacking in vitamin A, plus 8 cc. of milk from normal cows (milk added at bend in curve).
   B—Growth curve when 15 cc. of milk supplemented a basal ration lacking in vitamin B.

were made. The milk used came from cows on the high and low protein experiment, being conducted by other members of the Dairy Department. The high protein ration had a nutritive ratio of 1 : 2



Cow 292. On high protein ration. In fairly good condition.

Cow 301. On low protein ration. In poor condition.

Cow 285. On normal ration. In good condition.

Fig. 2.—While there was a striking difference in the physical condition of cow 292 and cow 301, there was practically no difference in the vitamin-A and vitamin-B content of the milk produced by the groups of cows they represent.

and consisted of alfalfa hay, corn silage, and a grain mixture comprised of equal parts of linseed oilmeal, cottonseed meal, corn gluten meal, soybean meal, peanut meal, blood meal, wheat gluten, and wheat bran. The low protein ration was made up of timothy hay,

corn silage, molasses, and a grain mixture, consisting of two-thirds corn and one-third made up of equal parts of oats, bran, and starch. The nutritive ratio of this ration was 1 : 13. None of the cows had access to pasture.

These rations differed essentially in two ways. The 1 : 2 ration contained alfalfa hay, which is somewhat richer in vitamins A and B than timothy hay of equally good quality, the roughage used in the 1 : 13 ration. Furthermore, the 1 : 2 ration furnished almost five times as much digestible protein as the 1 : 13 ration. At the time the vitamin-A potency of the milk was determined, the quality of the alfalfa hay was not as good as that of the timothy hay. This, together with the fact that the 1 : 13 ration contained yellow corn, a good source of vitamin A, would tend to equalize the vitamin-A content of the two rations. According to recent experimental work, the feeds used should not affect the potency of milk in vitamin B. The chief difference between the two rations, then, lay in the amount of protein furnished by each.

Milk from cows receiving a normal ration was used as a check. This ration consisted of alfalfa hay, corn silage, and a grain mixture made up of 4 parts corn meal, 3 parts oats, 1 part bran, and 1 part oilmeal. Its nutritive ratio was 1 : 6.2.

To determine the vitamin-A content of the milk produced by each group of cows, young albino rats were fed a ration lacking in vitamin A, until they started to lose in weight. Then varying quantities of milk from each of the groups of cows were added to the food supply of respective groups of rats (except a control group) and the effect on their physical condition and rate of growth noted. It was found that, while 2 cc. of milk caused growth to be resumed in every case, it required 8 cc. of either kind of milk to restore excellent growth. Those rats receiving 8 cc. of milk from the high protein cows showed a slight advantage in rate of growth, condition of the eyes, and general physical appearance over those receiving the same amount of milk from either of the other groups. This difference was so slight as to be almost negligible.

To determine the vitamin-B potency of the milk, albino rats were fed a basal ration lacking in vitamin B, to which were added different quantities of milk from each group of cows. Rate of growth and physical condition were used in evaluating the amount of vitamin B present. It required 15 cc. of milk from the normal group of cows, 16 cc. from the high protein cows, and 18 cc. from the low protein cows to allow good uninterrupted growth over an eight-week period. While these differences are small the results

were so uniform that it must be concluded that milk from the low protein cows contained less vitamin B than did that from either the high protein or normal cows.

The quality of the alfalfa hay fed the cows in the normal and high protein groups during the vitamin-B determination was superior to that of the timothy hay fed the low protein cows. Recent experimental work done at Pennsylvania State College has shown that the presence of vitamin B in milk is not dependent upon the presence of this vitamin in the ration of the cow, but is manufactured by bacteria in the cow's paunch. The possibility still exists, however, that the degree of this bacterial activity is influenced by the nature of the feed consumed. This may explain the difference in vitamin-B content of the milk used in this test.

The differences in the vitamin-A and vitamin-B content of the milk studied are not great enough to be of any practical significance. Apparently a cow can tolerate extreme levels of protein feeding without materially affecting these two factors of the milk.

CATTLE FEEDING EXPERIMENTS, 1927-28

PAUL GERLAUGH

The test reported here is for the most part a continuation of the test started December 29, 1927 by G. Bohstedt and reported at Livestock Day, June 1, and covered in special Circular 10 from this Station.

STEERS VS. HEIFERS

Lot 1, heifers, and Lot 2, steers, had been fed the same feeds for the five-month period, December 29 to May 24. For the first four months of this test the heifers outgained the steers, but the two lots finished the five-month test even so far as gains were concerned. Representatives of the Producers' Cooperative Commission Associations valued the steers May 24 at 25 cents per cwt. above the heifers. The heifers cost $5 per head less and weighed 17 pounds more than the steers when purchased. This lower cost price was responsible for a $5 greater profit for each of the heifers at that time.

There was a question in the minds of some as to how much longer the heifers could profitably be carried in comparison with the

steers. The test from June to August showed that the heifers were carried at a profit of $12.76 each, pork not included, while the steers made a profit of $23.00 each during the same period. While there was only 25 cents difference in market value May 24, there was $1.19 difference August 21. While the market value explains most of the difference, the steers outgained the heifers .12 pound daily and required considerably less feed to make a hundred pounds of gain. At the close of the summer test packers and market men considered the heifers quite a bit fatter than the steers. This would indicate that fat comprised a greater portion of the increase in weight made by the heifers than by the steers. Fat contains less moisture than lean tissue, so more feed is necessary to produce fat than lean. This probably accounts for the higher feed requirements and the lower daily gain made by the heifers.

VALUE OF PROCESSING ROUGHAGES

Lots 3, 4, and 5 continued the processed roughage comparisons excepting that mixed hay was substituted for corn stover and alfalfa hay, equal parts. Lot 4 was known as Lot 5 and Lot 5 as Lot 7 from December 29 to May 24. The initial values June 5 of these lots were the values assigned to the cattle May 24.

Lot 6 on chopped roughage gained 7 pounds more in the 77 days than did Lot 5 on whole roughage. During this time each steer in Lot 4 ate 522 pounds of chopped roughage. This would be a gain of about 28 pounds in weight of cattle to cover the expense of chopping a ton of roughage. However, the market men all valued Lot 5, 25 cents per cwt. above Lot 4.

Dressing percentages would have thrown some light on this point had the two lots been killed by the same packer, which was not the case. Most observers thot the chopped-roughage lot of cattle showed more paunchiness. The figures show more profit per steer in the lot receiving whole hay. This was due to a wider spread between initial and final market values.

Lot 3 was fed chopped and "predigested" roughage. Twice each week chopped hay in which was mixed 1 pound of convertor per 100 pounds of hay was placed in large boxes. Twice as many pounds of water was added and steam was turned into the bottom of the boxes to heat up the mass. After standing a day the box was opened and the "predigested" feed fed.

After the first four weeks the shelled corn was mixed with the hay so that both hay and corn were "predigested". The results

TABLE 1.—Steers Vs. Heifers, Value of Processing Roughages, Processed Dry Roughages Compared With Silage, Shelled Corn Compared With Ground Shelled Corn and Ground Ear Corn

June 5—August 21, 1928—77 days	Lot 1 Heifers	Lot 2 Steers	Lot 3 "Predigested" roughage	Lot 4* Chopped roughage	Lot 5* Whole roughage	Lot 6 Shelled corn	Lot 7 Ground shelled corn	Lot 8 Ground ear corn
Number of cattle per lot	10	10	10	10	10	10	10	10
Number of pigs following cattle	3	3	3	3	3	3	2	2
Value of cattle per cwt. at start	$12.57	$12.82	$11.90	$12.32	$12.15	$12.37	$12.37	$12.37
Weight of cattle June 5	776	754	692	736	720	725	724	722
Weight of cattle August 21	907	895	828	874	851	917	901	886
Average daily gain	1.70	1.82	1.77	1.78	1.70	2.48	2.29	2.13
Average daily ration:								
Corn†	9.09	8.96	9.09	9.09	9.09	13.87	13.44	14.31
Linseed meal	2	2	2	2	2	2	2	2
Hay‡	2.37	2.10	7.16	6.79	6.69	2.49	2.49	2.47
Corn silage	15.02	14.10	....	....	....	6.00	6.00	6.00
Feed per 100 lb. gain:								
Corn	534.4	490.9	513.6	508.6	534.2	557.7	584.7	670.1
Linseed meal	117.6	109.6	112.9	111.8	117.6	80.4	87.0	93.7
Hay	139.3	114.9	404.4	380.0	393.0	99.9	108.4	115.5
Corn silage	883.0	772.9	....	....	....	241.14	261.1	281.0
Cost of 100 lb. gain	$17.23	$15.68	$15.64	$15.36	$16.10	$14.57	$15.92	$14.69
Necessary selling price (no shrink nor pork credits)	13.24	13.27	12.52	12.80	12.76	12.83	13.07	12.80
Appraised value:								
Buffalo basis	16.00	17.00	15.75	16.25	16.50	17.15	16.75	16.50
Pittsburgh basis	15.50	16.50	15.75	16.25	16.50	16.75	16.50	16.50
Cleveland basis	15.50	17.00	15.75	16.00	16.25	17.00	16.50	16.25
Cincinnati basis	15.00	16.25	15.50	16.00	16.25	16.50	16.25	16.25
Value in lot (average market value minus $0.85)	14.65	15.84	14.84	15.27	15.52	16.00	15.65	15.52
Profit per animal:								
Not counting hogs	12.76	23.00	19.26	21.63	23.55	29.07	23.28	24.15
Crediting gain of hogs @ $11	15.58	25.31	21.73	23.64	25.67	31.51	24.02	24.78
Crediting feed saved by hogs	15.18	24.97	21.39	23.35	25.37	31.16	23.90	24.67

No charge made for chopping roughage for Lot 4; no charge made for chopping and predigesting roughage nor for convertor in Lot 3. Shelled corn $1.12 per bu.; 5 cents per bushel for grinding shelled corn; $1.12 per bu. of 70 pounds for ground ear corn; linseed meal $52.00; mixed hay $12.00 per ton; corn silage $6.00 per ton. Initial values of Lots 1 to 5 are the values placed on calves May 24. Buffalo values by Bob Martin, Pittsburgh values by Harry Forman, Cleveland values by F. W. Hollmer, Cincinnati values by Edw. Schneider. Gain on pigs valued at $11.00. Roughage fed to Lot 3 given on air-dry basis.

*Lots 4 and 5 in this test were Lots 5 and 7, respectively, in the previous test, Dec. 29 to May 24.

†Shelled corn, Lots 1 to 6; ground corn, Lot 7; ground ear corn, Lot 8.

‡Mixed hay, Lots 1, 2, 6, 7, and 8; predigested, Lot 3; chopped hay, Lot 4.

show 2 pounds less gain per steer in 77 days than where chopped hay was used in connection with the same amount of corn and linseed meal.

PROCESSED DRY ROUGHAGE COMPARED WITH SILAGE

Lots 3, 4, and 5 each received the same amounts of corn and linseed meal as Lot 2. Silage and mixed hay made up the roughage for the steers in Lot 2. Lot 2 outgained Lots 3, 4, and 5. It cost more to put 100 pounds of gain on Lot 2 because the cattle were noticeably fatter at the start of this test. This higher condition was due to the silage fed during the previous test.

After closing the preceding test it was not considered necessary to continue the lots receiving steamed cut roughage, ground roughage, or grain mixed with chopped roughage.

The cattle from these three lots—4, 6, and 8—were realloted on the basis of their gains during the 147-day test and called Lots 6, 7, and 8. The final values of Lots 4, 6, and 8 in the preceding test were averaged to obtain their initial values in the second test.

The calves of Lot 6 were given all the shelled corn they would eat, which amounted to nearly 14 pounds, 1 peck, per day. In addition they consumed 2 pounds linseed meal, $2\frac{1}{2}$ pounds mixed hay, and 6 pounds of silage. The lot averaged 2.48 pounds gain per day—until the hot weather came in July the average gain was nearly $3\frac{1}{2}$ pounds per day.

Anton Russ and Fred Graber, who fed the cattle, deserve credit for keeping the cattle sufficiently comfortable to make the good gains which were obtained.

SHELLED CORN, GROUND SHELLED CORN, AND CORN-AND-COB MEAL

The cattle in Lot 6 put on 100 pounds of gain cheaper than those of any other lot. Because of the more rapid gains a higher finish was obtained, which in turn was responsible for a greater spread between initial and final values and more profit for this than any other lot. A profit of $29 per steer, pork not included, in 77 days, is a return not often obtained.

Lot 7 was fed ground shelled corn in place of shelled corn. They consumed a trifle less corn than Lot 6 but the same amounts of the other feeds. It required more feed to put on a pound of gain in this lot. Because of this the gains cost 25 cents per cwt. more than those of the shelled-corn cattle and their selling price was 35 cents less, which made them about $5 per head less profitable, not including pork credits.

The two hogs that followed the ten head of cattle in this lot gained 80 pounds in the 77 days. The cattle received 185 bushels of corn, so there was .43 pound gain on the hogs from each bushel of ground shelled corn fed to the cattle. The pigs each received .2 pound tankage per day. This gives a pork credit of $7.35 to this lot of cattle or $0.73 per steer.

Three hogs following the ten cattle fed shelled corn made 242 pounds gain from the 190 bushels of shelled corn fed the cattle. This was at the rate of 1¼ pounds of gain on the pigs from each bushel of corn fed the cattle. This gave a pork credit of $2.44 per steer in Lot 6, which further widened the margin in favor of using shelled corn in place of ground shelled corn.

The calves of Lot 8 received ground ear corn. They ate more pounds of corn-and-cob meal per day but less corn than did either Lot 6 or 7. They gained less rapidly but there was less feed required for a pound of gain. Their lack of finish compared with that of Lot 6 handicapped them in market value and profit per head.

Two hogs following these cattle made 70 pounds of gain. The cattle received 157 bushels of corn, hence the pigs made .44 pound of gain from each bushel of ground ear corn fed to the cattle. This gain is quite comparable with that made by pigs following the cattle fed ground shelled corn.

The cattle fed ground ear corn made more pounds of beef from a bushel of corn than either those fed shelled corn or those fed ground shelled corn. If a farmer had a thousand bushels of ear corn to feed to cattle, this test would indicate that grinding the corn would give him more beef but less profit than shelling it. Had the corn-and-cob meal cattle been fed two weeks longer they should have been as fat as the shelled-corn cattle and would have consumed $0.60 worth more feed per steer in the 91 days than was eaten by each steer in Lot 6 in 77 days. Had they been fed two weeks longer and sold for the same money the lower pork credit would have made this lot less profitable than Lot 6.

We have combined the figures on Lots 1, 2, 3, 4, and 5 from December 29 to August 21, a period of 236 days. During this time each of the heifers in Lot 1 made a gain of 444 pounds and a profit, including pork credits, of $39.58, while the steers in Lot 2 made a gain of 450 pounds and a profit of $42.77.

The lot fed whole roughage gained 408 pounds per steer and made a profit of $37.08. The lot fed chopped roughage made a gain of 432 pounds and a profit of $40.06. There was a gain of 24 pounds of beef to pay the cost of chopping the roughage, which totaled 523

pounds of mixed hay, 483 pounds of stover, and 483 pounds of alfalfa. When the roughage was chopped and "predigested" the steers gained 386 pounds each and returned a profit of $30.23. This was a loss of 22 pounds of gain in addition to the cost of chopping and "predigesting".

FOWL-POX AND ITS PREVENTION

B. H. EDGINGTON AND ALVIN BROERMAN

Fowl-pox, or avian diphtheria, is an infectious disease of fowls caused by a virus that is present in the exudate and scabs of pox lesions. The disease is a serious problem on many poultry farms, often recurring several years in succession. Fowl-pox may occur in a flock at any time during the year, but usually is most severe during the fall and winter months.

Mortality in different outbreaks of the disease varies greatly. Accumulation of exudate in the larynx of affected fowls frequently results in death from suffocation. From an economic view point the greatest loss is sustained thru decreased egg production and loss of body weight. Since the disease occurs principally during the fall and winter months, it is present at a time when eggs bring the highest price.

Fowl-pox is manifested by eruptions on the comb and skin and by the formation of yellow spots on the mucous membrane. Pox eruptions usually appear as small, wart-like epithelial tumors on the comb, wattles, or skin of the head. The yellow spots on the mucous membrane of the mouth, throat, or eyes are masses of caseous exudate that adhere very closely to the underlying membrane. This form of the disease is commonly called avian diphtheria or canker. However, experimental and clinical evidence indicate that fowl-pox and canker are caused by the same agent—a filterable virus. The virus of fowl-pox varies greatly in virulence. It is present in the exudate and scabs of lesions of diseased birds and may remain virulent for a long time when kept in a dried state. The blood and internal organs of infected fowls may also contain the virus.

The disease is usually transmitted within the flock by virus that comes in contact with an injured skin or mucous membrane or thru the ingestion of infective material.

Fowl-pox affects chickens, turkeys, pigeons, waterfowls, and various wild birds. The disease can be transmitted readily from pigeons to chickens, and this may be a means of spreading the disease over a considerable area.

Injuries to the comb and wattles resulting from pecking offer common means for transmission of the virus. The heavy and light breeds of chickens are equally susceptible to the disease, but it frequently is seen to spread more rapidly in the latter. This is probably due to the large comb and the combative disposition of these fowls in contrast to the small comb and more docile temperament of the heavy breeds.

Roup and fowl-pox are frequently present in the same flock. Altho observations indicate that there is no direct relationship between these diseases, as birds that have had colds or roup are not necessarily immune to the virus of fowl-pox, and pox-immune birds may contract roup.

The early methods used to control fowl-pox were not satisfactory. The treatment recommended consisted in the removal of the scabs from the comb and skin tumors and the exudate from the mouth and eyes, followed by the application of various antiseptics. Obviously the extent to which treatment is carried depends largely upon the value of the bird. In dealing with a disease of this nature prevention rather than cure should be the primary aim.

Prevention.—Birds that recover from fowl-pox seldom again are affected with the disease. The fact that a resistance to fowl-pox is developed as a result of an attack of the disease has stimulated various attempts to produce an immunity by vaccination.

Efforts to produce immunity against fowl-pox during the past twenty years have developed two methods of procedure. One in which a vaccine is injected subcutaneously and the other in which the vaccine is applied to the scarified skin or feather follicle.

During 1927 the California Experiment Station reported studies in immunization of fowls against pox by the subcutaneous injection of vaccines. A vaccine prepared by mixing finely ground fresh pox lesions with a glycerin-phenol-salt solution was reported as giving the most satisfactory results. The immunity or resistance resulting from the use of this vaccine was shown to be of long duration.

In the same year the Oregon Experiment Station reported on a method of vaccination which was designated as "virus vaccination". An aqueous or glycerin suspension of finely ground pox scabs was applied to follicles of the skin of the leg from which the feathers

had been removed. This virus vaccination was claimed to produce immunity against both experimental and spontaneous infections.

The favorable results reported from the cutaneous application of fowl-pox vaccine and the simplicity of its administration encouraged attempts to determine the relative merits of several methods of applying a vaccine of this nature.

Preparation of vaccine.—A vaccine is prepared by grinding dried scabs from the combs of artificially inoculated fowls and mixing the powdered scabs in a glycerin-phenol solution. Only scabs from acutely affected birds should be used for this purpose. It is desirable to use a vaccine that has been recently prepared, since fresh active virus gives the largest percentage of immunity reactions.

Methods of vaccination.—During the fall of 1927, 1525 pullets were vaccinated on four farms and 469 unvaccinated birds were retained as controls in a study of the spread of pox from vaccination. The majority of the vaccination was by application of the vaccine to a scarified area of the skin of the thigh. The vaccine was prepared according to the method already mentioned. Fowl-pox had occurred on these farms during the previous year. Following vaccination a slight general depression was observed in some flocks. The birds were less active and food consumption was reduced. This depressing effect became most apparent during the second and third weeks after vaccination. In one flock there was evidence of roup at the time of treatment, and vaccination did not appear to increase the mortality of the vaccinated birds over that of those not vaccinated. However, this would be a questionable procedure to follow as a general practice.

The plucking of a few feathers from the skin of the thigh offers a more simple method of skin preparation than scarification. Experiments were conducted to determine the relative merits of the two methods of preparing the skin for application of the vaccine. An effort was also made to ascertain the minimum number of feathers that should be plucked to obtain a suitable "take".

In these tests four methods of vaccination were used: scarification of the skin; removal of one feather; removal of five feathers; removal of ten feathers.

The vaccine was applied with a small round camel's hair brush, the bristles of which were cut to give a desired stiffness. A small amount of the vaccine was applied by brushing against the orifice of the follicle.

The object in using these different methods was to determine the extent of cutaneous abrasion necessary to produce an immunity reaction following application of the vaccine and if it would influence the duration of the immunity.

White Leghorn pullets were vaccinated January 24, 1928 and held indoors in separate pens until termination of the test four months later. At this time immunity tests were conducted by applying a virulent pox virus to the scarified comb of these birds. The results showed no appreciable difference in the immunity conferred by these different methods of vaccination.

The feather follicle method of vaccination appeared to produce an immunity equally satisfactory to that resulting from a cutaneous scarification. While the removal of a single feather was sufficient to produce an immunity, the greater assurance of a "take" when five or ten feathers were removed makes this method of procedure more reliable. What the maximum duration of the immunity might have been was not determined, altho at the end of four months the immunity remained practically complete.

The results that were obtained with the use of the cutaneous method of virus vaccination support those already reported by other investigators and afford a basis from which a few suggestions for the control of chicken-pox may be formulated.

Practical application.—The cutaneous method of vaccination either by scarification of the skin or by plucking of several feathers results in an immunity that withstands attempts at severe artificial infection. The immunity appears equally firm following vaccination by scarification or feather plucking.

The simplicity, ease, and rapidity with which the vaccine can be applied particularly recommend the feather follicle method. While immunity can be established by applying the vaccine to a single feather follicle the plucking of five to ten feathers is recommended as giving additional assurance of a suitable "take". The development of a pox lesion at the seat of inoculation is regarded as evidence of a favorable immunity reaction.

Healthy young fowls from three to seven months of age may be vaccinated without danger of inducing a harmful chicken-pox infection. All susceptible fowls on the premises should be vaccinated. Vaccination of pullets while on range, before the combs are fully developed, is recommended. The probability of comb pecking and resulting infection is much less when the birds are on range than when housed. Obviously the small combs offer less opportunity of pox development than those that are fully matured.

Evidence suggests that when young fowls are vaccinated during the summer or early fall they will be protected against chicken-pox infection during the following winter and spring. Vaccination of laying flocks, by this method in its present stage of development, is contra-indicated, as the birds may be thrown out of production. The vaccine may be administered in flocks in which there is an outbreak of chicken-pox without increasing the severity of the lesions in fowls already infected or hastening the spread of the infection among the healthy birds.

It would not be wise to use a vaccine on a poultry farm where chicken-pox had never existed and when conditions were such that the infection would not likely be introduced. Routine vaccination should be practiced only on farms where the disease has occurred.

PRODUCING HATCHABLE EGGS

R. M. BETHKE AND D. C. KENNARD

New problems are to be faced in connection with the production of hatchable eggs as a result of the phenomenal development of the poultry industry leading to the increased demand for hatching eggs and the consequent intensification of methods of feeding and management of the breeding flocks. We must discover and apply the facts which deal with hatchability in order to proceed intelligently. The urgent need now is for practical information that will enable us to understand, and thereby control, the factors that affect the hatching quality of eggs so as to eliminate the uncertainties of the past.

Poor hatchability has been attributed to the weather and unknown causes or factors over which the poultryman has no control. In light of present knowledge, the hatching quality of eggs depends, not on unknown causes but principally on well established facts pertaining to feeding and management of the breeding flock. Other factors, such as low vitality stock, disease, inbreeding, and incubation may exert an influence that cannot be overcome by proper feeding or management. In the main, however, if 50 or 60 percent of the eggs fail to hatch we must assume that it is due to improper feeding and handling of the flock.

Laboratory tests have shown that a good chick ration must contain not only proteins, fats, and carbohydrates, but certain

minerals and vitamins as well. Likewise, the laying hen or pullet will not be an economical producer and lay eggs of good hatching quality, unless she is supplied the essentials with which to maintain her body and produce eggs. A deficient ration fed to a laying flock produces impoverished eggs, which in turn will develop into weak, improperly nourished embryos that may not mature to the hatching stage.

Many poultrymen realize that the hatchability of eggs produced in winter tends to be relatively low, especially if the birds are confined indoors. The reason for this poor hatchability has been commonly supposed to be due to close confinement, lack of exercise, heavy production, etc. Recent investigations, however, have shown conclusively that the low hatchability is not directly due to thsee causes but to improper nutrition—especially a lack of the antirachitic factor (vitamin D), which is supplied by direct sunlight.

Inasmuch as it is necessary to keep the breeders confined a considerable part of the winter, we are faced with the question of what are the possible substitutes for range that will insure good hatchability.

To secure definite information on the possible nutritional factors that might affect hatchability, the Ohio Station started an extensive series of investigations in the fall of 1924. The first series of experiments consisted of feeding an all-mash control ration of ground yellow corn 30, ground wheat 20, ground oats 20, wheat bran 10, winter wheat middlings 10, and meat scraps 10, supplemented in various ways, to several lots of 50 White Leghorn pullets. Oyster shells were available at all times. All pullets except those having access to a bare lot or bluegrass range were confined indoors where practically all direct sunlight was excluded. Lath bafflers in open front spaces provided the necessary ventilation. The experiment was started November 1. After the respective lots had been on experiment three and one-half months, all eggs available for incubation were set at weekly intervals until the middle of April. The results are summarized in Table 1.

It is evident that the control ration, fed to three separate lots of 50 birds each, failed to meet the requiremnts of laying pullets confined indoors to produce good quality hatching eggs. The poor hatchability of the control lots cannot be entirely explained upon a vitamin-A or -D deficiency, since cod-liver oil, which furnished both factors, did not exert a beneficial effect on hatchability. Likewise, skimmilk, which exerted a beneficial effect, did not furnish an appreciable amount of the two vitamins to prevent the occurrence of

deficiency symptoms noted in the control lots. Some beneficial effects were exerted by alfalfa hay. Direct sunlight, alone, as encountered in the bare lot was of little consequence. Of all the supplements, bluegrass range was by far the best.

TABLE 1.—Effect of Skimmilk, Alfalfa Hay, Sunlight, Cod-liver Oil, and Range on Hatchability

Ration	Total eggs set	Fertile	Chicks hatched	Fertile eggs hatched	Total eggs set hatched
	No.	*Pct.*	*No.*	*Pct.*	*Pct.*
Basal ration only*........................	1555	93.2	535	36.9	34.4
Basal ration plus skimmilk to drink	685	91.2	306	49.0	44.7
Basal ration plus alfalfa hay chopped.....	645	94.0	253	41.7	39.2
Basal ration plus bare outdoor lot.........	345	87.0	118	39.3	34.2
Basal ration plus cod-liver oil, 2% †........	1110	89.2	341	34.4	30.7
Basal ration plus bluegrass range†........	1525	94.2	873	60.9	57.2

*Average of three lots. †Average of two lots.

In a second experiment with 50 White Leghorn pullets to each lot, the value of various supplements to the basal ration were again determined. Since the control ration in the first trial did not contain sufficient vitamin A to prevent nutritional roup, the control ration of the second experiment was better fortified in this respect by the use of a larger proportion of yellow corn. The ration had the following composition: ground yellow corn 65 parts, ground wheat 20, meat scraps 10, bone meal 4, and salt 1. Oyster shells were kept before the birds at all times. At the same time as much direct sunlight as possible was admitted thru the open front spaces.

A—Direct sunlight promotes health of hens and improves hatchability of eggs. When ground is covered with cinders on south side of house snow and ice disappear soon after the sun shines and hens promptly take advantage of the sunshine.
B—These hens want to come out but the snow prevents.

The reel mash feeders were located in the direct sunlight to afford additional exposure of the birds. The results are shown in Table 2.

In spite of the increased amount of vitamin A and the admission of some direct sunlight into the pen, the control ration proved decidedly inferior to the rations fortified with soybean, alfalfa, or clover hay, or blue grass range. The feeding of cod-liver oil again did not improve the hatching qualities of the eggs.

TABLE 2.—Effect of Soybean, Alfalfa, and Clover Hays, Cod-liver Oil, and Range on Hatchability

Ration	Total eggs set	Fertile	Chicks hatched	Fertile eggs hatched	Total eggs set hatched
	No.	*Pct.*	*No.*	*Pct.*	*Pct.*
Basal ration only*	1187	91.4	387	35.7	32.6
Basal ration plus soybean hay	486	86.4	259	61.7	51.6
Basal ration plus alfalfa hay	1354	94.7	762	59.4	56.3
Basal ration plus clover hay	1026	95.8	568	57.8	55.4
Basal ration 2% cod-liver oil	332	93.4	88	28.4	26.5
Basal ration plus bluegrass range	835	78.2	401	64.0	48.0

*Average of two lots.

The results thus far indicate that legume hays exert some beneficial effect upon hatchability. However, in absence of direct sunlight (vitamin D) good hatchability could not be expected. This is brought out in comparing the results of the alfalfa-hay lot in trial 1 (Table 1) with the corresponding lot in trial 2 (Table 2) where the windows were kept open as much as possible. The direct sunlight that entered the pen apparently accounted for approximately 15-percent increase in hatchability.

TABLE 3.—Effect of Cod-liver Oil and Alfalfa Meal on Hatchability

Ration	Total eggs set	Fertile	Chicks hatched	Fertile eggs hatched	Total eggs set hatched
	No.	*Pct.*	*No.*	*Pct.*	*Pct.*
Basal ration only	174	92.0	41	25.6	23.6
Basal ration plus 1% cod-liver oil	532	96.8	155	30.1	29.1
Basal ration plus 3% cod-liver oil	285	95.8	77	28.2	27.0
Basal ration plus 5% alfalfa leaf meal	161	90.7	60	41.1	37.3
Basal ration plus 1% cod-liver oil and 5% alfalfa leaf meal	713	94.8	419	62.0	58.8

To test out this hypothesis further, several lots of 10 White Leghorn hens each were confined indoors where all sunlight was excluded. They received an all-mash ration of yellow corn 58.5 parts, wheat middlings 51, wheat bran 10, meat scraps 10, bone meal 2, fine oyster shells 4, and salt 0.5. This control ration was supplemented with different amounts of cod-liver oil, alfalfa leaf meal, and a combination of the two.

The data as recorded in Table 3 again clearly demonstrate the failure of the control ration to meet the requirements for good hatchability. The addition of 1 or 3 percent cod-liver oil did not improve the hatching qualities of the eggs, which substantiates the results with cod-liver oil in the two preceding trials. Adding 5 percent of alfalfa leaf meal to the control ration made for some improvement in hatchability but was not nearly as effective as the combination of cod-liver oil and alfalfa meal.

The mutual supplementing effect of alfalfa leaf meal and cod-liver oil in this trial afforded a possible explanation as to why the eggs of the lot fed a meat-scraps basal ration and having access to a bare lot (direct sunlight) in trial 1 (Table 1) did not hatch better than the control lot, whereas the eggs from birds having access to a bluegrass range maintained good hatchability.

TABLE 4.—Effect of Cod-liver Oil, Irradiation, Alfalfa Meal, and Skimmilk on Hatchability

Ration	Total eggs set	Fertile	Chicks hatched	Fertile eggs set hatched	Total eggs set hatched
	No.	*Pct.*	*No.*	*Pct.*	*Pct.*
Basal ration only*	184	97.3	36	20.1	19.6
Basal ration plus 2% cod-liver oil	252	95.2	59	24.6	23.4
Basal ration plus 2% cod-liver oil and 5% alfalfa leaf meal	250	98.0	144	58.8	57.6
Basal ration plus irradiation	—252	96.0	99	40.9	39.3
Basal ration plus irradiation and 5% alfalfa leaf meal	253	96.8	155	63.3	61.3
Basal ration without meat scraps plus skimmilk ad libitum and 2% cod-liver oil	470	92.3	230	53.0	48.9

*Basal ration:

Yellow corn	58.5
Wheat middlings	15.0
Wheat bran	10.0
Meat scraps	10.0
Bone meal	2.0
Fine oyster shells	4.0
Salt	0.5

To make certain our claims that a combination of vitamin D, or its equivalent, and alfalfa leaf meal were necessary to insure good hatchability with a meat-scraps ration fed indoors, a fourth trial was started. This involved the feeding of a meat scraps control ration supplemented with cod-liver oil, cod-liver oil and alfalfa leaf meal, irradiation with ultra-violet light, irradiation and alfalfa leaf meal, and feeding liquid skimmilk in place of water with a similar basal ration without the meat scraps but containing 2 percent of cod-liver oil. The results to April 17 are included in Table 4.

The data clearly show that a meat-scraps control ration, as used in the several trials, is in itself or with the addition of cod-liver oil or ultra violet irradiation inadequate for producing high

quality hatching eggs. The combination of the antirachitic factor as found in potent cod-liver oil, or its equivalent in form of ultra violet light, and alfalfa leaf meal, on the contrary, invariably resulted in improved hatchability.

Milk, on the other hand, when supplemented with cod-liver oil alone will materially improve the hatching qualities of the eggs. Apparently milk and alfalfa leaf meal or good quality legume hays have something in common that increases hatchability when fed in combination with cod-liver oil or when the birds are exposed to direct sunlight

A—September hatched pullets. They make another link in the chain for all the year egg production which is so necessary for special market requirements.

B—January hatcher pullets are becoming recognized as profit makers. To produce hatchable eggs in December and January requires special feeding and management.

In conclusion, the interpretation for poultry keepers of the foregoing results and discussion may be briefly summarized to emphasize the fact that good or poor hatchability of eggs is largely determined by the feeding and management of the breeders. From the foregoing results it is obvious that the nutritional requirements are much more exacting and specific when the breeders are confined indoors, where the caretaker must assume entire responsibility for providing all the requirements, than when the birds are permitted to protect themselves by securing certain vital nutritive factors, especially direct sunlight and green feed from the outdoor range. There is usually no difficulty in securing satisfactory hatchability during the spring months if the breeders have access to a suitable

outdoor range. The problem when the breeders are confined indoors for considerable periods, is to provide factors equivalent to those furnished by the outdoor range.

The most effective equivalent for green feed seems to be alfalfa, clover, or soybean hay of proper quality. Skimmilk or buttermilk serves as a partial substitute for green feed. To provide the equivalent of direct sunlight the use of a potent cod-liver oil is probably the most effective and the most practical at this time. In a locality where there is considerable sunlight, glass substitutes that admit the ultra violet rays may be used to advantage. Ultra violet light artificially produced is hardly to be considered as practicable as yet.

Finally it should again be emphasized that for good hatchability of eggs neither direct sunlight, potent cod-liver oil, nor ultra violet light proved effective unless supplemented by either green feed, a legume hay, or milk.

TIPPING BEAKS FOR "PICKOUTS"

D. C. KENNARD

Outbreaks of vent picking are frequent, but seldom do we observe just how they start or what takes place. It was the writer's opportunity recently to observe in considerable detail two typical outbreaks. Perhaps a brief relation of what took place and the measures of control applied may be helpful to others.

Case 1.—The trouble in a flock of 44 White Leghorn pullets started about 1 p. m., February 28, when one of the birds with prolapsus of oviduct was attacked by others of the flock and nearly killed. The trouble was discovered promptly and the bird was removed even before it died. But this proved only the beginning, for the hens had a taste of flesh and blood and their craving for more led them to attack hens with normal vents. Two hours later the birds were found in great commotion attacking each other and three had bleeding vents. In each case examination of these birds showed that the vents were in normal condition before the attack. The upper part of the vent in every case was picked so as to remove a wedge shaped piece of flesh about 1/8 inch deep and as wide as the beak, which showed how vicious the attacking birds were. The

wounds were bleeding profusely so that a number of other hens were pursuing the victims to get a taste of the blood on the feathers.

Treatment.—Two of the assailants, which seemed to be most vicious and probably the ringleaders most responsible, were caught so as to tip their beaks. This treatment made them harmless. The birds with bleeding vents were given a generous application of pine tar on the wound and surrounding bloody feathers. The tar is healing and repels further attack. This ended the trouble until six days later when one hen was found slightly picked. All that was done at this time was to apply pine tar. No further trouble resulted. Had the outbreak not been handled promptly this flock of birds would have surely suffered disaster.

Case 2.—In a group of 38 White Leghorn hens, at 2 p. m., April 11, one hen was observed plucking feathers very skillfully. She could pluck two to four each time and other hens came rushing to her to share the spoils. Only the one hen seemed to be doing the plucking. Her beak was tipped, rendering her harmless. Afterwards a few other hens made feeble but unsuccessful attempts to pluck feathers. No further evidence of feather picking was observed. Getting the right bird at the right time no doubt averted serious consequences in this case. However, on May 25, a different kind of outbreak occurred similar to Case 1 previously described but of greater intensity. About noon a bird had prolapsus of oviduct and was picked to death. This taste of flesh and blood set the flock on a rampage. Three hours later 3 other birds, with normal vents, were picked to death and 17 others of the flock of 38 hens had bleeding vents from being picked. Thus more than half the flock became victims of cannibalism because of one case of prolapsus of oviduct.

Treatment.—All the birds' beaks were tipped and pine tar applied to the picked vents. There was no further trouble.

Cause.—Because of lack of understanding we are inclined to blame the ration or think that cannibalism is caused from a lack of something in the ration, the need for fresh meat, salt, and so on; but in most cases such are not the real cause. There are many causes for outbreaks of cannibalism. In the epidemics cited the cause was definitely accounted for—a single case of prolapsus of oviduct in each instance. The more familiar we become with the real causes of cannibalism the more effectively we can cope with it. But the prime essential is to keep in close touch with the flock and always to be on the lookout for such outbreaks so as to stop them at the very beginning.

In both cases described the birds were confined indoors but had chopped alfalfa hay. Ten other groups with the same kind of management were kept in the same house. The rations in the two cases varied from the others. The birds in the first case received 5 percent meat scraps in the all-mash mixture; in the second, 20 percent, but these birds had grain, trough-fed, all they would eat, so that the percentage of meat scraps in the total feed consumed was also rather low—between 5 and 7 percent. Whether the low intake of meat scraps and high intake of corn were in any way responsible, we are not prepared to say, altho we doubt it. It seems probable that in each instance the outbreak resulted from a single case of prolapsus of oviduct. This aroused the craving for flesh and blood, which induced the birds to make a general attack. Had they not been started in some such way probably no outbreak would have occurred.

These observations offer an explanation of many cases of "pickouts" or "blowouts" frequently reported. In outbreaks such as described, unless the poultry keeper happens to see just what is taking place at a certain time, he will have difficulty in accounting for the trouble. The logical conclusion at a later time may be that there had been a considerable number of cases of prolapsus of oviduct, each the cause of a pickout; whereas there was but one case of prolapsus and the other pickouts were normal birds attacked as a result of cannibalism thus stimulated by the taste of flesh and blood. Furthermore, the caretaker would not be likely to handle all the birds so he would not become aware of the number that had been attacked. He would have very little idea of what had happened or how it took place.

CONTROL MEASURES

Tipping the beak.—Removal of the tip of the upper beak is undoubtedly most effective for the control of feather pulling and other forms of cannibalism. This treatment renders a bird harmless for a time so far as these vices are concerned. The tip of the beak is removed to the quick so it is tender for a while and leaves it in such shape that it is impossible for a bird to firmly grasp either feathers or flesh. Tipping the beak if properly done involves little pain or discomfort to the bird and seldom causes any bleeding. About three weeks is required for the beak to grow out again. During this time the birds usually forget their past vices and no further trouble results. In some cases where the vice has become

A—Showing the first cut at side of beak
B—After a slight prying and pulling against flat side of knife blade the tip of beak is removed

A—Cockerel after removal of tip of upper beak
B—Tips of upper beaks after removal

chronic subsequent treatments may be required. Tipping the beak appears not to interefere with the bird's eating an all-mash feed nor to affect her egg production.

Another effective application of tipping the beak is to prevent male birds from fighting. Fighting often becomes a serious matter when it is necessary to put strange male birds together. Many a valuable breeder has been killed or permanently injured in this way. Removal of the point of the upper beak will prevent their fighting for two or three weeks, and in the meantime they become acquainted so that there is little danger of fighting. Should certain birds become troublesome later, the treatment of such individuals should be repeated.

Like most procedures there is a right and wrong way, and in this case the right way is easy and simple and the most effective. By referring to the figure it will be seen that there is very little cutting. The edge of the upper beak is cut in about 1/8 inch and 1/8 to 3/16 inch from the tip, depending on size of beak and length of tip. Then by prying and pulling with flat side of knife the point of beak is removed by tearing and not by cutting. The small cut serves only to get a hold and start the tearing. By tearing the beak it can be removed much closer to the "quick" without bleeding and it is so much easier than paring, even with a razor edged knife. After the tip is torn loose one should pull down toward the lower beak to remove the lower knife edge of the other side opposite where the starting cut was made. This gives the removed tip a V shape and prevents a bird from getting a firm grasp of a feather or flesh. After a little practice beaks can be removed at the rate of 200 to 225 an hour when one has a helper to handle the birds.

DIRECT TO PACKER BUYING OF HOGS IN THE UNITED STATES

GEO. F. HENNING

The number of hogs marketed direct to packer has increased greatly during the last few years. For the year 1927 nearly one-third, 32.4 percent, of the total hogs slaughtered by a group* of packers in the middle western states, were purchased direct, Table 1.

*This group of packers represents nearly 75 percent of total animals slaughtered under federal inspection.

During 1920 about one-fifth of the purchases were direct. Since then the increase has been gradual from year to year except for 1927. The yearly percentage purchased direct remained about the same for the four years, 1922 to and including 1925; increased slightly to 27.1 percent in 1926; then rose abruptly to 32.4 percent for 1927. This was by far the largest increase for any one of the 8 years. A greater percentage of the total slaughter was purchased during the months of October to February than during the remaining months of any year, with few exceptions. The largest relative purchases for each year, with one exception, were during the winter months. In December 1926, this group of packers purchased 38.3 percent of their kill for that month thru direct sources, the largest amount for any one month of the 8 years. In December 1927, 37.1 percent were purchased direct, the second largest amount for the period.

TABLE 1.—The Percentage of Hogs Purchased Direct by a Group of Packers in Middle Western States, 1920-1928

Month	1920	1921	1922	1923	1924	1925	1926	1927	1928
January	19.0	22.6	24.7	27.9	26.7	24.7	26.1	34.5	33.5
February	19.0	21.5	24.1	26.3	23.8	22.0	25.6	32.4	34.4
March	17.8	19.0-	24.5	25.1	23.0-	21.1-	24.0	35.2	36.8
April	17.9	22.1	24.9	24.2	24.9	25.3	24.2	32.9	35.1
May	16.4-	23.4	25.2	23.0	26.3	25.1	23.4	29.0	32.6
June	20.1	25.3	25.0	24.3	27.0	26.9	22.2-	31.9	36.4
July	18.9	23.8	24.0	22 3-	25.7	25.7	24.0	31.1	....
August	19.9	21.2	23.1-	23.4	23.1	24.1	25.3	29.9	....
September	23.8	25.5	24.8	23.1	24.3	26.3	27.4	30.6	....
October	23.0	23.6	25.7	25.8	24.6	27.0	29.0	28.2-	....
November	23.0	23.4	27.7	28.2	27.0	29.4	31.6	31.6	....
December	26.2	28.0	30.8	30.2	25.7	32.5	38.3	37.1	....
Average	20.2	23.4	25.7	25.6	25.3	26.1	27.1	32.4	....

The smallest percentage of direct purchases was in March of three years, and in May, June, July, and August in one year each. Usually during the summer months a smaller percentage of directs were purchased.

While the number of hogs slaughtered monthly by this group of packers is proportional to the number received at the 64 large stockyards in the United States, the numbers purchased direct show more seasonal variation, Table 2. If the hogs in the U. S. were marketed in equal numbers thruout the year, one-twelfth or $8\frac{1}{3}$ percent would be marketed each month, but in observing Table 2 it is noticed that a greater number was marketed during January, February, March, November, and December, than during the remaining seven months of the year.

TABLE 2.—The Average Monthly Percentage of U. S. Hog Receipts at 64 Markets, Slaughter and Direct Purchases of a Group of Packers in Middle Western States 1923-1927

Month	Receipts at 64 markets	Slaughter	Direct purchases
	Pct.	*Pct.*	*Pct.*
January	11.1	11.2	11.4
February	8.9	8.6	8.4
March	8.7	8.7	8.2
April	7.7	7.6	7.3
May	7.9	7.9	7.3
June	7.9	8.6	8.5
July	7.2	7.6	7.2
August	6.5	6.5	6.0
September	6.8	5.8	5.6
October	7.8	7.3	7.2
November	9.0	8.9	9.5
December	10.5	11.3	13.4
	100	100	100

The percentage purchased direct was slightly greater than the normal number marketed during the season at the 64 livestock markets, during January, June, November, and especially during December.

This probably was due in part to the greater number of hogs marketed at that time, which enables agencies selling direct to sort and grade car loads suitable for direct sales.* Then too, some of these agencies close down or operate very little during the late summer months.

The average number purchased direct in December was 13.4 percent of the total for the year, while the number slaughtered was 11.3 percent. The number marketed (10.5 percent) was relatively less than either the slaughterings or directs. As far as seasons go, it would seem that the number slaughtered was greater, partly at least, because of the greater number purchased direct.

The relationship between direct buy and slaughter may be observed from Figure 1. The two curves at certain months and during some of the years are very close together and at other times wide apart. This is particularly true for January 1924, 1926, and 1927. For each year the number slaughtered remained about the same, but the number bought direct varied greatly. This same relationship can be observed in Table 1. The same table shows a large increase during 1927. This too is evident in Figure 1. The graph further shows how the numbers slaughtered and purchased

*With many agencies it is more difficult to grade and sort uniform loads during the summer because of light receipts.

direct varied from season to season. Figure 1 shows that for the last 5 years the greatest variation between direct buy and slaughter occurred during the winter months.

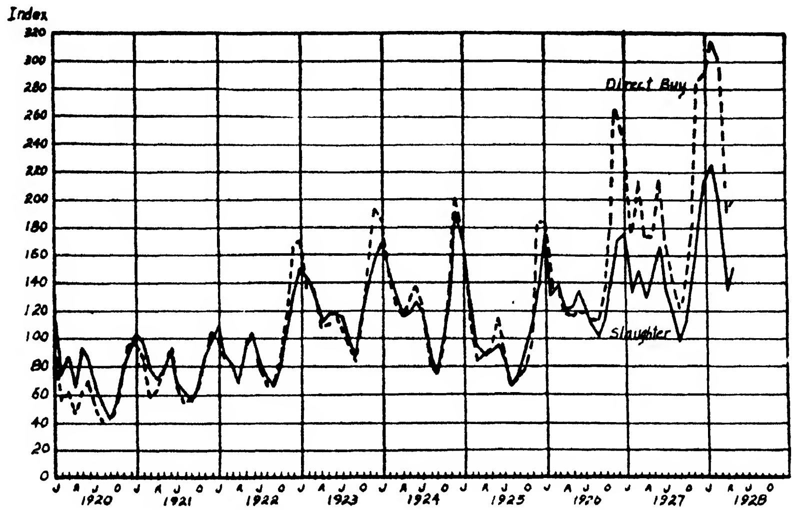


Fig. 1.—Direct buy and total slaughter of hogs by packers in a group of middle western states for the years 1920-1928. Average 1920-1925 equals 100

Therefore, a comparison of the winter months of one year with those of another proves interesting, Table 3. The months of October, November, December, January, and February were placed in one group and the remaining seven months in another group. For the five years 1923-1927 it was found that 47 percent of the total slaughter took place during the five winter months and 53 percent during the other seven months.

The total kill doubled from 1920 to 1927. This was owing in part to the increased capacity of some of the packing plants, but more especially to additions of more packers each year. However, the total slaughter was more uniform during the last five years. When comparisons between years are made this point must be kept in mind. For that reason a comparison of one year with the year preceding is more easily understood than a statistical analysis.

In the 5 winter months of 1921-22 in comparison to the previous year, hog receipts at the 64 markets declined, but slaughter increased and directs increased still more. The following year U. S. receipts increased 22.3, slaughter 32, but directs 47 percent. In 1923-24, receipts increased 20.6 percent, followed by about the same

proportional increase in slaughter and directs. This marked the peak of our hog production cycle, for the next three annual periods show declines.

During this period of increasing receipts, direct purchases increased relatively more than did slaughter.

TABLE 3.—Comparison of Total Slaughter, Direct Buying, and U. S. Hog Receipts at 64 Markets for Five Winter and Fall Months, and the Seven Spring and Summer Months March to September, Inclusive

Year	Total slaughter	Directs purchased		Receipts 64 markets	Percent of preceding year		
		Number	Percent of slaughter		Slaughter	Number direct	Receipts 64 markets
Five winter and fall months (October to February, inclusive)							
1920–21	10,873,030	2,526,564	23.2	19,570,000	....	....	....
1921–22	11,600,403	2,890,181	24.9	18,723,000	106.7	114.3	95.6
1922–23	15,317,083	4,266,771	27.8	22,905,000	132.0	147.6	122.3
1923–24	18,857,706	5,091,991	27.0	27,645,000	123.1	119.3	120.6
1924–25	18,650,799	4,643,690	24.8	26,161,000	98.9	91.2	94.6
1925–26	16,571,037	4,655,504	28.0	19,291,000	88.8	100.2	73.7
1926–27	18,887,896	6,352,091	33.6	18,237,000	113.9	136.4	94.7
1927–28	22,784,519	7,641,176	33.5	21,487,000	120.6	120.3	117.8
Seven spring and summer months (March to September, inclusive							
1920	12,557,509	2,366,459	18.8	22,576,000	....	....	....
1921	12,892,050	2,950,811	22.8	21,560,000	102.6	124.6	95.4
1922	14,501,159	3,559,884	24.5	23,069,000	112.4	120.6	106.9
1923	20,139,858	4,766,112	23.6	29,475,000	147.5	133.8	127.7
1924	19,863,707	4,959,402	24.9	28,328,000	92.8	104.0	96.1
1925	15,518,835	3,880,743	25.0	21,653,000	78.1	78.2	76.4
1926	21,804,680	5,288,989	24.2	21,371,000	140.5	136.2	98.6
1927	24,199,567	7,662,366	31.6	22,882,000	110.9	144.8	106.7

For the five winter months 1924-25 receipts declined slightly, 5.4 percent; slaughter 1.1 percent; and directs 8.8 percent. This period was the beginning of the downturn in the hog cycle. One year later receipts had fallen considerably, likewise slaughter, but the number purchased direct remained about the same. During 1926-27 receipts declined still farther from the year before but slaughter increased only 13.9 percent, whereas directs rose 36.4 percent. More hogs were purchased direct during this period than any preceding period. Receipts, slaughter, and directs all increased in about the same proportion during the five months of 1927-28, with slightly more than ⅓ of the hogs slaughtered purchased direct.

In looking at the comparisons of the spring and summer months, the same relationship exists, with a few exceptions. During the summer of 1924 receipts and slaughter declined somewhat, but directs increased. This is just the reverse of directs during the

winter of 1924-25 compared with a year previous. During the summer of 1925 receipts, slaughter, and directs all declined in about the same proportion, thus holding the same relationship as existed a year earlier with much larger receipts.

The summer of 1926 saw slightly less receipts than did the summer of 1925, but slaughter increased 40 percent and directs 36 percent. The following year, 1927, saw increasing receipts and slaughter, but a much larger increase in directs. During this period a much larger part of the kill was bought direct than for any preceding summer period.

Thus it would seem that packers increase the proportion of directs to total slaughter during periods of increase in the hog marketing cycle; hold the percentage with the peak in cycle, sometimes a slight decrease; hold about the same proportion during the decrease in receipts; and then increase the proportion during the next period of increasing receipts.

This at least seems to be characteristic of the movement during the last seven years. Whether this same relation will hold during the next five years would be difficult to estimate. Likewise the percentage bought direct may or may not show a continued increase. With such a large increase in percentage of directs, from 27.1 percent in 1926 to 32.4 percent in 1927, as compared to preceding years, a slight falling off might be expected. On the other hand the new contacts formed by the packers may prove satisfactory and the increase in percentage of directs retained during declining hog receipts, which seem to be approaching. Another year or two will give much interesting information.

SEASONAL CHANGES OF CLEVELAND AND PITTSBURGH MILK PRICES

R. U. BATTLES

An analysis of the prices paid to farmers for milk in the Cleveland and Pittsburgh markets over the 14-year period from 1914 to 1927, inclusive, shows that there has been a decided change in the seasonal variation from year to year.

Table 1 shows the total percentage change in price from the beginning to the end of the period covered for each month for these

two markets. The prices used are the actual prices received by farmers for their milk divided by the all-commodity price index to eliminate fluctuation due to changing price levels.

TABLE 1.—Percentage Change of Milk Prices for Each Month From 1914 to 1927 on Cleveland and Pittsburgh Markets

Month	Total percentage change	
	Cleveland	Pittsburgh
January	—18.72	—13.78
February	—15.86	—10.14
March	—14.30	—1.82
April	8.84	2.61
May	20.80	8.32
June	21.32	11.70
July	13.00	9.70
August	9.10	2.60
September	2.34	—2.66
October	—4.16	—0.26
November	—12.48	—0.52
December	—10.92	—5.98

It is evident from Table 1 that the price during the surplus season increased on both markets. However, the increase in price on the Cleveland market during the surplus season has been greater than that of Pittsburgh. This indicates that the market conditions in the Cleveland area of late years have been such that the early summer price has not been depressed as much as that of Pittsburgh.

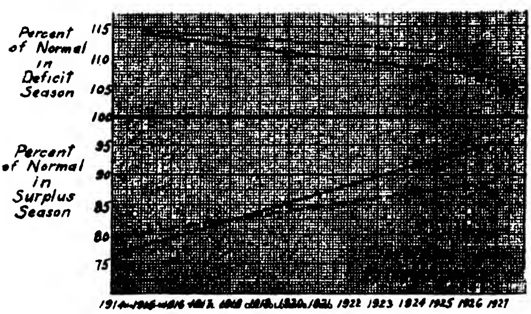


Fig. 1.—Trend of milk prices in surplus and deficit seasons on Cleveland and Pittsburgh markets

The base payment plan at Cleveland has been in operation only since July, 1926. Its effect, therefore, is not apparent in this study which ends in 1927. It would seem logical, however, to assume that when the base payment plan at Cleveland has been longer in effect, that there would be a still greater stability in Cleveland prices, providing both continue their present methods of payment to farmers and their present method of handling surplus.

Figure 1 shows the trend in surplus-season and deficit-season milk prices on the two markets. May, June, and July were combined to represent the surplus season, while November, December, January, and February were combined to represent the deficit season.

The chart and table show that the winter price decreased on both markets to a considerable extent. However, the decrease on the Cleveland market was greater than the decrease on the Pittsburgh market. This indicates that the market conditions have been so changed as to lower the winter price of milk, over the period covered, to a greater extent in the Cleveland area than in the Pittsburgh area. Likewise the summer price has tended to rise in both markets, but to a greater extent in Cleveland than in Pittsburgh.

A comparison of the seasonal price changes in the two markets makes apparent a definite tendency for the Cleveland price to become more stable than the Pittsburgh price, as far as seasonal variation is concerned. In other words, the ordinarily low summer price is becoming higher each year at a more rapid rate in Cleveland than in Pittsburgh and the ordinarily high winter price is becoming lower each year at a more rapid rate in Cleveland than in Pittsburgh.

RATIO OF POULTRY FEED TO THE PRICE OF EGGS AND POULTRY

JOHN H. SITTERLY

Of the total cost of producing poultry and eggs on Ohio farms from 50 to 60 percent is feed cost. Profits in poultry would therefore be expected to bear a close relation to the ratio between feed and poultry and egg prices. In the accompanying table and chart a

TABLE 1.—Yearly Average Price of Eggs, Poultry, and Poultry Ration

Year	Eggs per doz.	Poultry per lb.	Poultry ration per cwt.	Value of 6 doz. eggs plus 4.3 lb. of poultry	Equiv. in feed of 6 doz. eggs and 4.3 lb. of poultry
	Cts.	*Cts.*	*Dol.*	*Dol.*	*Lb.*
1910	23.5	11.9	1.42	1.92	135
1911	19.5	10.6	1.32	1.62	123
1912	23.0	11.3	1.51	1.86	123
1913	22.5	12.2	1.41	1.87	133
1914	23.3	12.5	1.51	1.93	128
1915	22.6	12.0	1.69	1.86	110
1916	25.5	14.2	1.77	2.14	121
1917	36.0	18.2	2.95	2.94	100
1918	42.0	22.8	3.12	3.50	112
1919	46.7	25.8	3.25	3.90	120
1920	51.0	27.2	3.26	4.23	130
1921	35.5	22.1	1.69	3.08	183
1922	30.8	20.4	1.66	2.72	164
1923	31.2	20.4	1.82	2.75	151
1924	33.0	20.6	1.93	2.87	149
1925	36.3	22.0	2.28	3.12	137
1926	33.4	22.8	1.88	2.98	159
1927	30.1	21.4	1.91	2.72	142
Av.					134

comparison is made for each year since 1910 of the cost of one hundred pounds of a poultry ration (45 pounds of corn, 35 pounds of wheat, 10 pounds of oats and 10 pounds of meat scrap) and the price of 6 dozen eggs and 4.3 pounds of poultry. The latter being assumed as a fair division of the income from poultry.

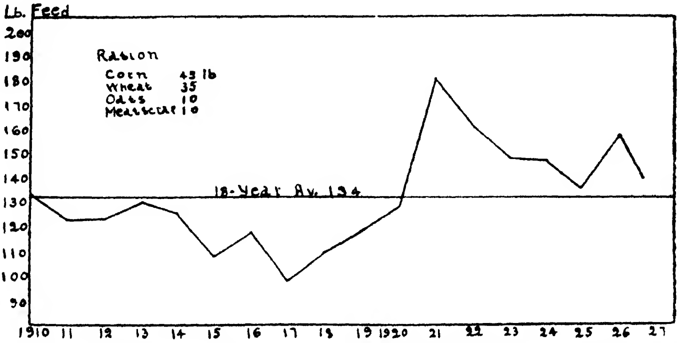


Fig. 1.—The ratio of the cost of the poultry ration to the price of eggs and poultry. Ohio farm prices of grain, eggs, and poultry, and Buffalo prices of meat scraps in 1910-1919 and Cleveland prices in 1920-1927, were used.

The period 1916 to 1920 was one of relatively high priced grain and low priced eggs and poultry. On the chart it will be seen that during this period the amount of feed that the 6 dozen eggs and the 4.3 pounds of poultry would buy was below the average. The years 1921 to 1927 show the opposite of the previous period. The price of grain has been relatively low as compared with egg and poultry prices and the result has been that the amount of feed that could be bought has been above the average.

OHIO FARM EXPENSES

J. I. FALCONER

In the September-October, 1926, issue of the Bimonthly Bulletin there was published an index of Ohio farm expenses for the years 1923 to 1926. In this article the index is brought down to 1928. The data are as of March or April for each year. The weight, or relative importance, given the various items has been computed and checked from many sources, including the detailed data on expenses from more than 6,000 farms in various sections of Ohio. Constant weights have been used for each year.

The prices used have been secured from the various trade agencies supplying the farmer and from tax reports and other miscellaneous sources. For building material, clothing, furniture, groceries, and fuel the price index of the U. S. Bureau of Labor has been used.

Index Number of Ohio Farmers' Expense

Item	Weight	1923	1924	1925	1926	1927	1928
		Index No.	Index No.	Index No.	Index No.	Index No.	Index No.
Labor	14	150	163	163	167	172	172
Machinery	10	125	144	138	135	134	137
Feed	14	140	127	153	127	127	153
Taxes	8	215	211	218	219	227	237
Fertilizer	4	141	139	146	148	142	144
Buildings	10	188	182	180	175	167	159
Clothing	14	196	191	190	180	168	172
Furniture	4	184	175	170	164	157	158
Groceries	11	141	141	159	151	147	144
Fuel	2	218	181	174	175	168	153
Miscellaneous	9	156	150	161	151	145	140
Total	100						
Weighted index		164	162	168	161	158	162

The table shows a 4 percent increase in expenses for 1928 over 1927. Of the various items, feed shows the largest increase, while taxes comes second. A comparison with the index of prices received for Ohio farm products as given on page 159 will show that for the past six years the fluctuation in annual expenses has not been as great as has that of receipts.

INDEX NUMBER OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

It is of interest to compare the July and August Ohio farm prices and income for 1928 with those of the same months for 1927. The prices received in 1928 were more than ten points above those of 1927. The total income from the sales of farm products, however, was nearly ten points below that of the previous year. The small wheat crop and low marketing of hogs was largely responsible for this situation. The Ohio wheat crop of 1928 is estimated to have been less than 30 percent of that of the past five-year average.

A new column appears in the table this month, namely, "Price Paid by Farmers for Commodities Bought: U. S.". The new index is based upon the prices paid by farmers for wheat they buy, including both purchases for the farm and for the home. The index is prepared quarterly by the United States Department of Agriculture and is based upon the retail price of these commodities and not upon the wholesale price.

Trend of Prices and Wages, 1910-1914=100

	Wholesale prices all commodities U. S.	Weekly earnings N. Y. state factory workers	Prices paid by farmers for commodities bought U.S.	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales*
1913	102	....	100	100	104	100	104	....
1914	100	100	101	102	102	102	105	....
1915	103	101	106	100	103	107	106	....
1916	130	114	123	117	113	113	121	....
1917	181	129	150	176	140	119	182	....
1918	198	160	178	200	175	131	203	....
1919	210	185	205	209	204	135	218	....
1920	230	122	206	205	236	159	212	154
1921	150	203	156	116	164	134	132	90
1922	152	197	152	124	145	124	127	88
1923	156	214	153	135	166	122	134	95
1924	152	218	154	134	165	118	133	95
1925	161	223	159	146	165	110	159	98
1926	154	229	156	136	170	105	155	108
1927	149	231	154	131	173	99	147	94
1927								
January	150	232	....	126	172	....	145	102
March	148	234	154	126	....	99	144	93
July	147	228	....	130	174	....	147	103
August	149	231	....	132	....	....	149	99
September	152	233	154	140	....	....	149	83
October	152	231	....	139	175	....	150	88
November	152	226	....	137	....	....	149	88
December	152	233	153	137	....	....	145	90
1928								
January	151	230	....	137	158	....	141	96
February	151	230	....	135	....	....	141	87
March	150	233	155	137	....	98	146	87
April	152	227	....	140	172	....	152	85
May	154	230	....	148	....	....	167	98
June	153	232	156	145	....	....	164	106
July	154	229	....	145	173	....	163	94
August	155	....	....	....	....	....	158	90

*Average month 1924, 1925, and 1926=100.

Continued from page 194

No. 420, Fertilizers for Early Cabbage, Tomatoes, Cucumbers, and Sweet Corn, Donald Comin and John Bushnell. The four crops are grown in rotation in a fertilizer and lime experiment on the Washington County Truck Farm. The results for the third rotation and for twelve years are given and form the basis for practical conclusions.

No. 421, Mixtures of Spring Cereals and Flax in Ohio, L. E. Thatcher. Yields, feeding and market values of barley, oats, flax, and spring wheat and of various combinations of these grains are given.

No. 422, Cherry Pollination Studies, J. S. Shoemaker. This is a discussion of season of bloom in relation to cross-pollination, self- and cross-compatibility tests of the sweet, sour, and duke varieties, and of factors associated with incompatibility.

No. 423, The Duration of Immunity in Dogs Following the Single-Injection Method of Anti-Rabic Vaccination, Alvin Broerman and B. H. Edgington. This bulletin reports the results of experiments to determine the duration of immunity following a single injection of anti-rabic vaccine and its efficacy in protecting against street virus from different sources.

No. 424, Dairy and Other Livestock Costs in Medina County, Ohio, F. L. Morison. This bulletin presents an analysis of the livestock production costs of 23 typical farms in Medina County in the heart of the dairy region of northeastern Ohio.

No. 425, Public Revenue in Ohio With Especial Reference to Rural Taxation, H. R. Moore and J. I. Falconer, presents information designed to assist to an understanding of the separate parts of the tax system of Ohio and of how each part has functioned in the scheme of the entire system. "In view of the tax problems confronting Ohio at the present time, information concerning the volume, growth, sources of public revenue, and benefits received from the expenditure of public funds is particularly opportune."

No. 426, Fruit Varieties in Ohio, II—Damson Plums, J. S. Shoemaker. In 1912 the Station began a test collection of damson varieties. In this bulletin a description of twenty-four of these varieties and an account of their behavior are given.

The Monograph Bulletins are sent free upon request by postal card or letter addressed to the Experiment Station, Wooster, Ohio.

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